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A Quantitative Analysis of Whether Elementary Teachers' Science Kit Usage and Beliefs Can Predict State Science Assessment Scores

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A QUANTITATIVE ANALYSIS OF WHETHER ELEMENTARY TEACHERS' SCIENCE KIT USAGE AND BELIEFS CAN PREDICT STATE SCIENCE ASSESSMENT SCORES

Tony E. Rice, Ph.D.

Western Michigan University, 2016

The purpose of this survey was to describe and analyze the perceptions of elementary school teachers' in a Midwestern state concerning their use of a science kit program, including to what extent a school's state science assessment scores can be predicated from the level of science kit usage.

Prior research indicates that elementary school teachers lack the confidence in teaching science primarily because of their weak undergraduate training in inquiry-based instruction and the lack of a strong science background. Authors such as Dickerson et al. (2006) and Riggs and Enochs (2006) argued that science kits and the materials included in them are valuable in increasing teacher confidence.

The teacher perceptions I collected matched the literature quite closely as far as what the teachers found to be of the most value and use. Teachers perceptions of the science kits were positive including: (a) student engagement in using the science kits, (b) use of most of the instructional items included in the kits, (c) the amount of teacher confidence in using them, (d) the support from the math and science center for using them, (e) and the professional development provided. Teachers liked using many components of the kits, especially the experiments. Their main complaint concerned time: time to teach science and time to complete the kit lessons.

I used multiple regression to understand the components of the kit program that had a significant correlation to the state test scores. The following variables could

explain a high proportion of the variance (.796): (a) teacher confidence, (b) student science learning success, (c) teacher beliefs about science education and (d) the percentage of students eligible for the National School Lunch Program.

These findings might lead to school principals and teachers increasing their 5th grade state science exam scores by using the findings to identify which components of the kit program are most important in this endeavor.

A QUANTITATIVE ANALYSIS OF WHETHER ELEMENTARY TEACHERS'
SCIENCE KIT USAGE AND BELIEFS CAN PREDICT STATE SCIENCE
ASSESSMENT SCORES

by

Tony E. Rice

A dissertation submitted to the Graduate College
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Doctoral Committee:

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Louann Bierlein Palmer, Ed.D.
Mark Jenness, Ed.D.

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DEDICATION

I wish to dedicate my research to my wonderful wife, Jayne, who has sacrificed tremendously over the past many years, by taking care of our home, our children and our many special needs foster children, while providing me with the time I needed to complete this document and my Ph.D. I also want to thank my wonderful children, Shane and Sophia who have been so patient with me while I worked on my research project. To my parents, Tom and Ruth Rice, I want to thank them for always holding high expectations for me and providing the support, encouragement, and push for me to do my very best.

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First of all, I wish to acknowledge and thank my wonderful wife, Jayne, who has sacrificed tremendously over the past many years, by taking care of our home, our children and our many special needs foster children, while providing me with the time I needed to complete this document and my Ph.D. I also want to thank my wonderful children, Shane and Sophia who have been so patient with me while I worked on my research project.

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CHAPTER I

INTRODUCTION

Did you know these scientific facts before today?

TO GERMINATE IS TO BECOME A NATURALIZED GERMAN.

A PISTOL OF A FLOWER IS ITS ONLY PROTECTION AGAINST INSECTS.

H₂O IS HOT WATER; CO₂ IS COLD WATER.

WATER IS COMPOSED OF TWO GINS – OXYGIN AND HYDROGIN - OXYGIN IS PURE GIN AND HYDROGIN IS GIN AND WATER.

WHEN YOU BREATH, YOU INSPIRE. WHEN YOU DO NOT BREATH, YOU EXPIRE. (O'Donnell, 2007, p. 3)

These statements were taken from real school work including exams and papers, and while funny, they lose their humor when one understands the source of them.

O'Donnell (2007) offered these as evidence that such students never had a real understanding of these scientific concepts, starting with a poor introduction to science in elementary school.

Chylinski (2009) addressed this lack of scientific understanding by stating:

“Learning science in elementary school helps students to develop problem solving skills and critical thinking skills. However, the science curriculum needs to be strengthened so that it encourages students to more actively explore their environment” (p. 4). Chylinski goes on to say that teachers of elementary school science are often discouraged by the directives from administration to put emphasis on other subjects like math and reading, and the related required district and state testing for those subjects. He further stated that our youth need to become critical thinkers about their surroundings to best prepare them for our future world.

Yet, a recent international study revealed that the United States dedicated on average, only about 10% of its instructional time to 4th grade science. This ranked the U.S. above such countries as Australia and England where their numbers were 6% and 8% respectively, but below such countries as Spain and Portugal where they devoted 16% and 17% respectively of their instructional time to science (National Center for Educational Statistics, 2011).

The results of such limited time are visible in the Trends in International Mathematics and Science Study (TIMSS), which is a 4th grade international science exam. The TIMSS's most recent results revealed that for the United States, only 15% of the tested students met the advanced benchmarks and 49% met the high benchmarks, while in Singapore, over twice as many (33%) met the advanced and 68% met the high benchmarks. Such gaps need to be addressed (National Center for Educational Statistics, 2011).

Background

Various researchers have studied the relationship between the amount of core science knowledge an elementary school teacher has and that person's self-efficacy in teaching science. Specifically, the area studied was the amount of core science knowledge an elementary school teacher should have received in their undergraduate years. Closely interwoven with this is the concern of teacher self-efficacy in relation to teaching science (Howitt, 2007). Self-efficacy is the idea that teachers feel confident in teaching science based upon their prior knowledge of core science ideas.

Dobey and Schafer (1984) found that many classes in elementary school were being taught by inexperienced teachers with weak backgrounds in the sciences, and

therefore had a poor sense of self-efficacy related to their abilities to teach science subjects. The results of a study by Dobey and Schafer revealed

that teachers with more science content knowledge, were also more confident and self-assured in their teaching. Perhaps by helping teachers acquire more of the science knowledge needed for teaching children, teachers will develop more confidence in teaching science, will teach more science, and will develop the security necessary for dealing with the uncertainties of inquiry teaching. (p. 49)

Appleton (2002) stated that during these times, many teachers would teach some elementary school science using what they called, “science activities that work”.

Appleton’s research on this is more fully explained in Chapter II.

Dobey and Schafer (1984) also noted there are some teachers who did have a sufficient quantity of science knowledge, but were not adequately trained to use inquiry-based science instruction. While defining inquiry-based instruction, Bruner (2015) stated that:

Inquiry-based instruction is a teaching technique in which teachers create situations in which students are to solve problems. Lessons are designed so that students make connections to previous knowledge, bring their own questions to learning, investigate to satisfy their own questions and design ways to try out their ideas. Such investigations may extend over a long period of time. Students communicate through journal writing, oral presentations, drawing, graphing, charting, etc. Students then revise their explanations as they learn. (p. 1)

Dobey and Schafer go on to note: “some science educators suggest that teachers who have science knowledge tend to exclude inquiry and instead stress their knowledge to the

extent that their sole purpose is to drill facts into the learner” (p. 39).

Some researchers like Ucar and Sanalan (2011) believed the best way to facilitate more elementary school student science learning is by altering teachers’ pre-service programs. This alteration would not necessarily involve more science classes, but a change to their teaching methods classes. Yet, Tosun (2000) addressed the beliefs of pre-service elementary teachers toward science and science teaching, and found that the interest in teaching elementary school science did not change even after taking their science teaching methods classes. Tosun’s study suggested that the traditional science methods classes must provide a different approach to teaching science which would hopefully lead to an increase in self-efficacy toward teaching this subject as well. Santau, Maerten-Rivera, Bovis and Orend (2014) are also researchers who believed that just adding more science content requirements within an elementary school teacher program many not lead to elementary school teachers who are comfortable in teaching elementary school science.

Other researchers like Rennie, Howitt, Evans and Mayne (2010) professed that the best elementary school science teaching could take place with inquiry-based science being taught by use of *science kits*. Such science kits contain all equipment necessary to perform inquiry-based elementary school science for an average sized classroom, including a teacher’s manual that covers the curriculum being taught, instructions for completing the experiments contained with a specific science unit, and all assessments needed to ascertain student outcomes. Student guides and journals are also included in such kits (FOSS Program Components, 2005). In their study of teachers using science kits, Jones and Eick (2007) described such kits as:

The curriculum packaged as a kit included lesson plans, hands-on materials, background information, supplemental readings, and performance assessments. The kits' lesson plans provided a structure based on preset curricular topics that constructively allow students to work through a series of hands-on activities following a learning-cycle model and work up to inquiry-based activities in which students are gathering and analyzing data. (p. 494)

Sullivan-Watts, Nowicki, Shin and Young (2013) researched the use of science kits in teaching elementary school science, examining ways to make new teachers more comfortable with teaching elementary school science by use of an inquiry-based curriculum, even though they did not necessarily have a good background in the basic sciences. These curricula are available nationally and contain inquiry-based hands-on activities and experiments to conduct in order for the teachers and students to get a better understanding of science concepts. While these curricula provide the teachers and students a path to follow in learning science concepts, they can also help to improve the teacher's confidence in teaching science and providing many positive science learning experiences.

Sullivan-Watts et al.'s (2013) study also found that students who utilized the science kits in their science lessons the longest, performed the best; receiving the highest scores for the teachers and their students. In a similar vein, Foley and McPhee (2008), in their study of hands-on science teaching, found that,

Research shows that inquiry-based curriculum materials, in comparison with traditional teaching methods, work better to help students engage in,

reflection, and apply scientific knowledge and science process skills and perform better on assessments than traditional methods. In addition, students in classes where science is taught using hands-on methods are generally more favorable to science and have a better understanding of the nature of science than students in textbook classes. (p. 1)

Research points to science kits being an important resource to support elementary teachers in teaching science, but gaps regarding usage of such kits still exist, especially as related to student outcome connections.

Problem Statement

Over the last fifty years, many efforts have been rendered, many research studies performed, and many dollars spent in an attempt to address problems associated with teaching science in elementary school (Mazur, 2009). The U.S. Department of Education (2004) encouraged more research in this area of improving elementary school science programs by stating, “Over the last decade, researchers have scientifically proven the best ways to teach reading. We must do the same in science. America’s teachers must use only research-based teaching methods and the schools must reject unproven fads” (p. 1).

Researchers have examined the reasons why over the years the teaching of science in elementary school has been considered the “black sheep” of the elementary school curriculum. Some reasons revolved around pre-science elementary school teachers’ preparation and elementary school teachers’ lack of core content in science (Tosun, 2000), as well as the lack of confidence in teaching science content (Ginn, Tulip, Watters, & Lucas, 1995). These concerns, along with the efforts presently being used today to increase teacher confidence and comfort levels in teaching science via science

kit usage and inquiry-based science, have been investigated by the aforementioned researchers along with many others like Dobey and Schafer (1984) who studied the lack of core science content, Ginn and Foster (1983) who studied inadequate pre-service training, and Appleton (1995) who studied teacher self-efficacy in teaching science.

Another reason elementary school science education has often been shorted on time and importance is federal and state policies, which historically have placed more importance on the reading, writing and math curricula. Alberts (1993) stated another reason, as "...science, all too often is treated by teachers as an elective" (p. 3).

Indeed, Davis and Smithey (2009) addressed some of the responsibilities an elementary school teacher has with including science into their daily curriculum, noting "Teaching science can be a challenge, especially for beginning elementary teachers. Most elementary teachers teach multiple subjects including language arts, mathematics, social studies, and science; some also teach other subjects such as art, music and computer literacy" (p. 745). Such responsibilities make it difficult to teach science as a core subject with such time restraints.

As a result, the NAEP report (1992) stated that, "The results, nationally, is that K-8 science is given little classroom time" (p. 124). And over two decades later, these findings tie in closely with the recently mentioned international study, which reflected that the United States is including science education in their classrooms only approximately 10% of the instructional time (National Center for Educational Studies, 2011).

So here is a situation in which elementary teachers have, (a) limited science training (Ucar & Sanalan, 2011), (b) limited methods preparation in the undergraduate

program (Dobey & Schafer, 1984), (c) limited confidence in teaching science (Appleton, 1995), and (d) efforts to support teachers via the providing of science kits and some research surrounding such kits (Rennie, Howitt, Evans, & Mayne, 2010). But there are still many unknowns regarding the use of such science kits, such as the preparation of those teachers who use science kits, and whether or not students whose teachers use kits score higher on state tests.

Purpose and Research Questions

The purpose of this study, therefore, is to add to the research in the area of elementary school science as recommended by the U.S. Department of Education (2004). Specifically, the purpose of my study is to collect the perceptions of teachers in a large number of elementary schools in which the teachers have been using the “Science Unit Kit Program” over the years. Perceptions will focus on: (1) actual kit usage over time; (2) levels of training and self-efficacy; (3) assessment usage, (4) provided support levels and; (4) any connections to science learning outcomes.

The overall purpose of doing this study is to determine what the effect of each school’s respective independent variables (coded variables developed from the survey indicating the teachers’ perceptions of teaching elementary school science with the use of science kits) have on that school’s 5th grade state science exam score. This purpose was brought to fruition as I developed a multiple regression equation by putting the aforementioned coded variables (independent variables) developed from the teachers’ responses along with the school’s respective demographics and school’s combined teacher demographics, and the school’s scaled 5th grade state science exam score (dependent variable). This will be discussed later in Chapter III.

The two main research questions for this study are:

1. For teachers presently using or have used the “Science Unit Kit Program” in elementary schools which have fully adopted a science kit program (i.e., kits available for all teachers in grades K-5), what are their perceptions regarding:
 - a. levels of science kit usage, including the inquiry-based experiments, assessments and associated science reading, writing and journaling activities;
 - b. perceived value of aspects of the science kits in helping students learn science concepts;
 - c. their confidence levels in teaching elementary school science using the kits as a resource;
 - d. support levels from the school, district and regional math and science center;
 - e. quality of professional development from the kit designers;
 - f. any success related to science student learning outcomes; and
 - g. beliefs regarding the teaching of science in elementary school?
2. To what extent can schools’ state science assessment scores be predicted from the level of science kit usage by teachers and other related input variables, as controlled by various school and teacher demographic variables?

Conceptual Framework

My study used a survey research approach to study teacher perceptions regarding usage levels of, a science kit program, and beliefs toward science teaching, as the independent variables, and the influence of these input variables on the scaled 5th grade

state science exam scores, the dependent variable. Other variables such as teacher and school demographics have been controlled for this study.

The conceptual framework shown in Figure 1 illustrates the core aspects of my study.

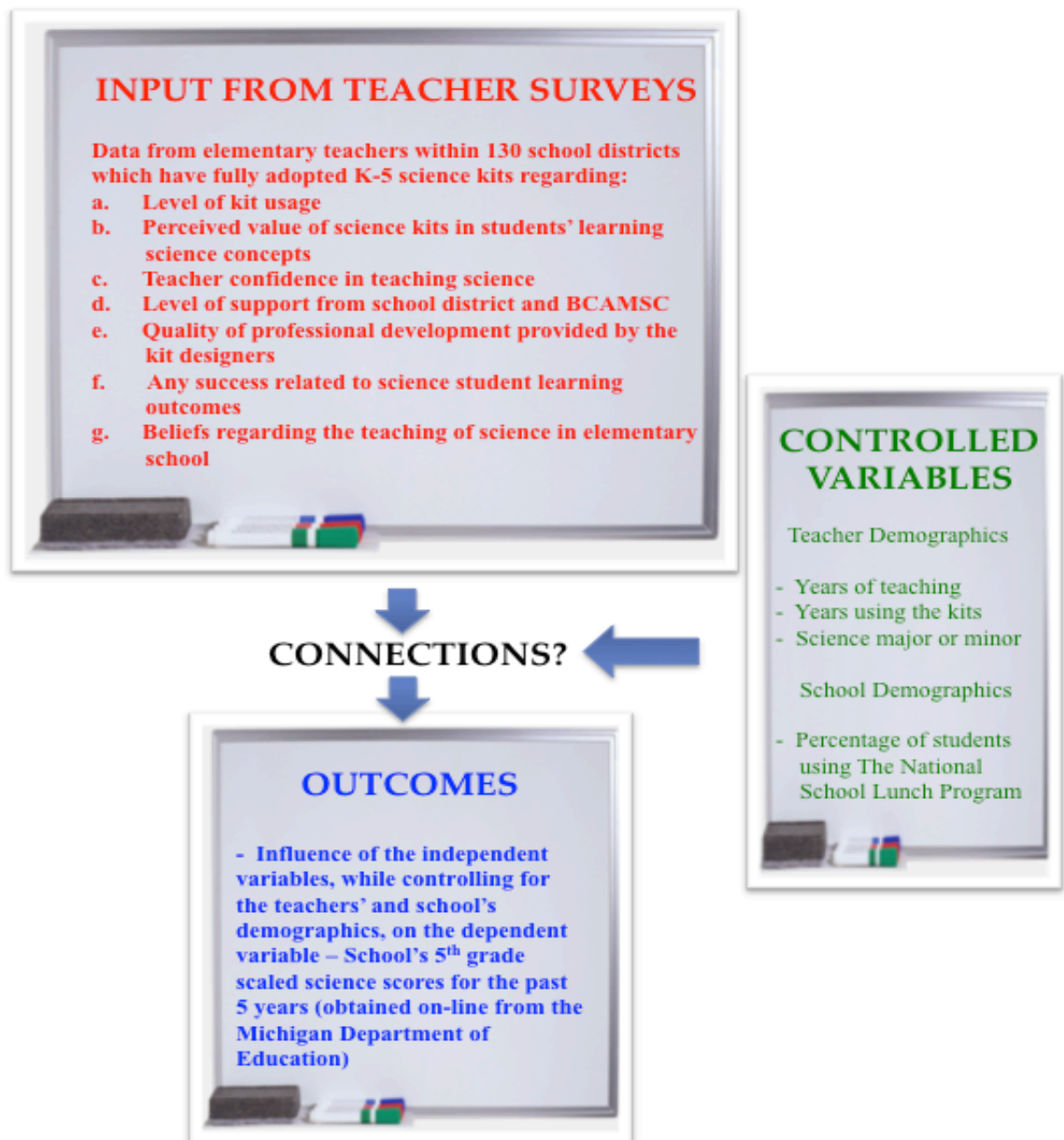


Figure 1. Rice (2016) conceptual framework for a quantitative study of an elementary school “Science Unit Kit Program”.

Within Figure 1, the first compartment represents the input received from the teacher surveys. This input revolves around the teachers' perceptions while teaching elementary school science with a kit program and involves: kit usage (how and how often); assessment usage (how much and how often); the use of reading and writing in science (how much and how often); teachers' perceived value of the kits in students learning science concepts; teachers' self-efficacy in teaching elementary school science; support for the teachers from the district and the school; professional development (quantity and quality) provided by the kit designers; any success regarding the teaching of science in elementary school and teachers' beliefs about teaching elementary school science? The second compartment to the right in Figure 1 contains the teacher and school demographics. The teacher demographics include the number of years teaching; the number of years using the science kits; and if the teacher has a science major or minor in their undergraduate studies. The school demographics consist of the percentage of students using the National School Lunch Program.

The third compartment contains the outcomes of this study. It includes the results of the 5th grade state science assessments for each school, which were used to ascertain to what extent the various input variables related to science kit usage levels can be used to predict such state science assessment outcomes. This compartment also contains any perceived results by the teachers on student success in learning science.

Methods Overview

I utilized a quantitative research approach in this study to determine if there is a correlation between various independent and dependent variables. Along these lines, Creswell (2003) stated that, "... if the problem is identifying factors that influence an

outcome, the utility of an intervention, or understanding the best predictor of outcomes, then a quantitative approach is best” (p. 21). The independent variables were the teachers’ perceptions of various aspects of their science kit usage, and the outcome variables were: (a) perceptions of such usage impact on their students’ science achievement, as well as, (b) their schools’ 5th grade state science exam scores. The population of participants was 1,495 elementary school teachers identified as using the science kits within 70 schools throughout a given Midwestern state. Once the data was collected, descriptive statistics and a linear regression were used for its analysis.

Significance of the Study

This study is an attempt to add to the literature information concerning teachers using science kits in elementary school. This study has provided data on teachers’ perceived feelings about science education in elementary school and their level of kit implementation including experiments, assessments, professional developments on the kits, and reading and writing in science. This study also investigated a correlation of each specific piece of data cited above to the school’s respective score on the state’s 5th grade science proficiency exam. Hopefully the results of this study have given the participating teachers and schools some insight into where changes might be made to help increase students’ science understanding.

Chapter I Summary

As stated initially, the concerns about teaching science in elementary school have been under discussion for many years. The concerns involve how to teach elementary school science with teachers who may lack sufficient information, training or skills to do a good job in the classroom with science subjects. Some of the concerns involved in this

discussion dealt with the teacher's lack of basic core knowledge in science; inadequate pre-service training in methods of teaching science; and the lack of skills involved in conducting inquiry-based instruction in their classrooms.

So in an attempt to make teaching elementary school science more user friendly for both the teachers and the students, the use of science kits have been introduced into the discussion. The teachers' level of usage of these science kits were evaluated and compared to their 5th grade state science exam scores in order to determine which of the many variables or combinations of them in the study contributed significantly to those scores.

Moving on to Chapter II, you will find a detailed review of the literature related to this topic.

CHAPTER II

LITERATURE REVIEW

This chapter provides an overview of the literature that is relevant to my research questions. The format of this chapter includes: (a) teacher self-efficacy; (b) the “Nature of Science;” (c) teacher pre-service training; (d) inquiry based instruction; (e) use of science kits and their components; (f) professional development on kit usage; (g) kit formative and summative assessments; (h) reading and writing in science; (i) teacher demographics including years of teaching experience, years of using the science kits and undergraduate major/minor in science; (j) teacher gender; and (k) school demographics including the percentage of students using the National School Lunch Program.

For better understanding of my research, the path to the implementation of inquiry-based science kit usage needs to be better understood. Questions such as: Why are many elementary school teachers uncomfortable in teaching science; what might be done in education to alleviate this discomfort; and possibly most importantly, how does the teacher’s feeling about science in general, and specifically teaching science, affect the students’ success in the classroom? The answers to these questions have a direct relationship to my research study in that the development of science kits over the last three decades has been one of the efforts to, not only assist elementary school teachers in becoming more comfortable in teaching science, but also to make it a fun experience for the students.

Teacher Self-Efficacy

In this section, I review the literature concerning the importance of teacher self-efficacy, their feelings about science and the teaching of science. The role that these

factors play in good elementary school science teaching has been researched in depth and summarized in this section.

Over the years, when discussing how elementary school teachers feel about teaching science and the science in general, researchers have conducted various studies to better understand this very important component of elementary school science teaching.

Koballa and Crawley (1985) discussed the differences about beliefs, attitudes and behavior as related to elementary school science teaching. They stated,

An elementary teacher judges his/her ability to be lacking in science teaching (belief) and consequently develops a dislike for science teaching (attitude). The result is a teacher who avoids teaching science if at all possible (behavior). This strong interrelationship of beliefs, attitudes, and behavior dictates the inclusion of belief measurement in elementary science teaching research which, up until now, has been slighted. (p. 223)

Koballa and Crawley (1985) go on to say that self-efficacy depends upon a teacher's situation. In other words, a teacher might have high self-efficacy in certain subjects like reading and writing, but that self-efficacy does not necessarily apply to his/her abilities to teach science.

A study, conducted by Riggs and Enoch (2006), addressed this self-efficacy issue depending upon what subject is being taught. Their research dealt with assessing the level of self-efficacy with new practicing elementary school teachers. They used 71 teachers in the study, both urban and rural. These teachers were presented with a survey which was developed by a group of expert science teachers.

Riggs and Enochs (2006) discussed their findings on what leads to a teacher developing good self-efficacy by stating:

Teacher self-efficacy studies have also tended to focus on investigation of teacher efficacy beliefs in general rather than specific subject areas. For elementary teachers in particular a subject specific instrument would be more informative.

Teacher efficacy beliefs appear to be dependent upon the specific teaching situation. Teachers' overall level of self-efficacy may not accurately reflect their beliefs about their ability to affect science learning. A specific measure of science teaching efficacy beliefs should be a more accurate predictor of science teaching behavior and thus more beneficial to the change process necessary to improve students' science achievement. (p. 627)

Riggs and Enochs (2006) also addressed teacher self-efficacy in teaching science and what might contribute to their behavior in the classroom. In discussing teachers' feelings about teaching science in elementary school, they stated that "attitudes to science and consequent teacher behaviors may arise because of teachers' beliefs about their ability to teach science and children's ability to learn science" (p. 626).

This ability is referred to as "self-efficacy" and is explained by Gibson and Dembo (1984) when they say:

Teachers who believe student learning can be influenced by effective teaching (outcome expectancy beliefs) and who also have confidence in their own teaching abilities (self-efficacy beliefs) should persist longer, provide a greater academic focus in the classroom, and exhibit different types of feedback than teachers who

have lower expectations concerning their ability to influence student learning. (p. 570)

Ramey-Gassert, Shroyer, and Staver (1996) also addressed this issue by conducting a study to determine what factors influence science teaching self-efficacy of elementary school teachers. This study consisted of 23 experienced elementary school teachers who had attended a 3-year teacher education program in the central United States. The study used self-reporting instruments, background questionnaires on their science and teaching preparation, surveys on previous science experiences and teacher interviews. These researchers were looking for any correlations between teachers' personal feelings about their abilities to teach science, namely, personal science teaching efficacy and their students' ability to learn, namely, science teaching outcome expectancy.

Ramey-Gassert et al.'s (1996) study gave greater insight into how teachers "develop science teaching efficacy beliefs, richer insights into their professional growth experiences, and other factors which lead to highly efficacious science teaching" (p. 285). Their study also provided information into teacher pre-service programs and professional development experiences which lead to better science teacher self-efficacy, better science teaching and better student understanding. They go on to state:

Important implications from this study of science teaching self-efficacy indicate the need for early and continuing positive science experiences; successful science teaching experiences in pre-service teacher preparation; and teacher professional development such as success in quality science courses and workshops, access to resources and time, and supportive colleagues and administrators. (p. 312)

In this section, I not only found the definition of self-efficacy, but how it is developed and how important it is in teaching. I also learned that teachers can have different levels of self-efficacy depending upon which subject they are teaching and that the amount of self-efficacy in a certain subject is easily recognized by the students and reflected in their subsequent learning of that respective subject.

Nature of Science

Along these lines of teacher self-efficacy, the teacher's understanding of the "Nature of Science" is equally important. Lewthwaite, Marray, and Hechter (2012) emphasized the importance of teachers having the ability to teach science to elementary students be an important component of the teacher education programs. They say,

The significance of the "Nature of Science" (NOS) in the science education literature and science literacy reform efforts internationally over the past two decades is not easily overlooked. The current consensus and emphasis on the NOS from a curricular viewpoint essentially dictates that it is a component of teacher education that cannot be set aside or cursorily examined. Despite this emphasis, there appears to be little justification *pedagogically* for NOS inclusion in teacher education programs leaving NOS inclusion as somewhat of a mythical ideal rather than a supportive construct for pre-service teachers of science. (p. 379)

Kegan (2000) goes on to address the importance of pre-service elementary teachers developing a positive attitude about science. Kegan stated:

As middle-years teacher educators, we believe our primary role is to assist teacher

candidates in developing a positive perception of science as a learning area, and, with more challenge, teacher candidates' perceptions of their capabilities as teachers of science. Our hope and ongoing practice as science teacher educators is to assist teacher candidates in developing a revised view of self and science as a teaching area. Our focus is on the narrative of the transformative story; providing our candidates with opportunities that foster their self development and means by which they can see their evolving self-development. (p. 53)

Along these lines of teacher self-efficacy and their feeling about science and science teaching is addressed when discussing a teachers' pre-service programs.

Young (1998) discussed a study of 105 undergraduate pre-service teachers with various areas of interest, namely, science, math, English and technology. They were required to take a ten-week course where their study time was devoted to 50% learning teaching styles and 50% core science content. The non-science students' subject was anatomy and the science students studied botany. Interview and survey techniques were used in this study.

Young (1998) wanted to find if there were changes of pre-service teachers' attitudes about science and science teaching over this ten-week study. She found:

There was little evidence from the interviews conducted in the research reported here that the students accepted science as being of value to them in their everyday lives; Indeed they mainly saw science as a school only area of study. However responses to the questionnaire revealed a high valuation of science. Perhaps this indicates that students believe they should value science but do not recognize its effects on themselves. If students perceive little value in science, they may not be

able to relate science to primary pupils' everyday experiences. It may be that the effects of science on individuals as well as society need to be made overt to all students at the beginning of their course and reinforced throughout the science units. (p. 108)

The dominant findings in my research for this section dealt with the components of a teacher's self-efficacy and how it relates to a teacher understanding of the "Nature of Science." I learned from these researchers that the concept of the "Nature of Science" is often overlooked in many teachers' pre-service training programs. And, they stated that this lack of training is a serious deficit in teacher education programs and later are reflected in a teachers love for science, love of teaching science and subsequent student learning. This pre-service preparation will be addressed in the next section.

Teachers' Pre-Service Preparation

Teacher pre-service training varies from one educational institution to another while trying to turn out the best teachers possible. In this section, I researched the various aspects of pre-teaching programs that many researchers feel lead to future good teaching practices, including: (1) need for changes in pre-service teacher methods classes, (2) need for a strong science background, and (3) roadblocks to implementing good science teaching.

Teaching science at the elementary level has always become somewhat burdensome for many reasons, including pre-service training, science core content and basic self-efficacy. These problems are not new but have been around for many years. Todd (1958) stated that:

The vast majority of the studies in this field point to the discouraging fact that

most elementary-school teachers have had little or not training in science; the training they do possess is of little value in their work with elementary-school children; and as a result of their lack of training, they “shy away” from teaching science. (p. 385)

Even today, researchers such as Zembral-Saul (2009) are still investigating ways to better instruct pre-service teachers on how to teach science in their elementary school classrooms. Zembral-Saul’s research is discussed in the following section.

Need for Changes in Teacher Methods Classes

In this section I researched the literature concerning how a teacher’s self confidence or self-efficacy can be enhanced with possible changes to their pre-service methods classes. The question I examined was: is it possible for these undergraduate students to see inquiry-based lessons, and participate in them as well, in their methods classes and how these experiences can lead to a more confident science teacher?

Some of the more current research in this matter of changing pre-service methods classes has been done by Zembral (2009). He suggested that undergraduate teacher programs establish what he calls a “framework” “as a means of addressing problems of practices faced by pre-service teachers, creating coherence for the design of teacher education experiences, and serving as a tool for shaping a design-based research agenda” (p. 687). He goes on to state that this “framework” acts as a scaffolding for pre-service teachers while developing their thinking and practices on teaching elementary school science. After reviewing three prior studies on this subject, Zembral concluded that,

In the end, the take home message is grounded in the practice of using a common conceptual framework to provide coherence to teacher education experiences.

Equally as powerful is the notion of teacher educators engaging in the interactive process of examining the impact of their practices on pre-service teachers' learning and contributing what they have learned back into the development of learning to teach experiences. (p. 713)

Young (1998) suggested needed changes to the pre-service elementary school teachers' methods classes to enhance the attitudes of these students about science and teaching science, no matter if they had a strong science background or not. She goes on to say:

Courses need to be structured not only to enhance the attitude of non-science students but to maintain and develop those of science students. With respect to science there is a wide range of ability, experience and achievement in the students who enter the teacher training program. Some enter with two science "A" levels, others with one science related qualification, others with a broad science foundation and others with limited experience. Obviously learning activities need to be differentiated so that all students continue to develop. Students need to be helped to understand the purposes of science and to view science as a process. Science should not be seen just as an area of the National Curriculum but as part of their whole education. (p. 108)

Another study showed how teachers' feeling about teaching science can change while experiencing different styles of teaching in college. Lucas and Dooley (2006) conducted a study on 33 first year pre-service elementary school teachers and 35 second year pre-service elementary school teachers in Australia. Pretest and posttest evaluations were involved in the study. The lessons were developed and taught by these researchers

in two different fashions. The first group of randomly selected pre-service teachers received their instruction predominantly by the professors used inquiry-based science investigations for over 50% of the class time was devoted to investigations. The second group of pre-service teachers did not receive this treatment but were exposed to a more traditional type of lesson where lecture and research time composed most of the class time. Their findings were similar to those found by other researchers mentioned in the literature review section, namely, Sherwood and Gabel (1980). These researchers found that after conducting this study, the attitudes about science teaching showed a significant improvement where as, the attitudes toward science in general showed no improvement.

Experience in teaching also plays a role in teachers' attitudes about teaching science. Bryan and Abell (1999) discussed where the knowledge on how to teach comes from. They stated that, "The heart of knowing how to teach cannot be learned from coursework alone. The construction of professional knowledge requires experience" (p. 121). They addressed their feelings of the importance of finding and understanding the pre-service teacher's overall beliefs about learning and teaching elementary school science. This study came to the conclusion that:

...a preeminent goal of science teacher education should be to help prospective teachers challenge and refine their ideas about teaching and learning science and learn how to learn from experience. By understanding prospective teachers' beliefs, their various experiences, and the relationship between their beliefs and practice, we will be in a better position to design more effective programs and create supportive environments for their development of professional knowledge. (p. 137)

Many researchers, when discussing the importance of developing self-efficacy in students preparing as pre-service elementary school teachers, quote psychologist and experts in the field. Bandura (1977) is one of the research psychologist who discussed what he feels are the two most important factors in developing a teacher's self-efficacy. An individual's feeling about their actions and resulting outcome is one and the other is the individual's feeling about their ability to deal with various tasks. Bandura stated, "...that an analysis of outcome expectancy and the ability to cope with a task (self-efficacy) would facilitate the prediction of behavior, for example, an individual rating high on both factors would behave in a confident manner" (p. 192). Bandura feels that by understanding these concepts, universities and colleges could make changes to lead to better pre-service elementary school teachers' programs.

Cakiroglu, Cakiroglu, and Boone (2005) also mentioned Bandura (1977) and his theory on self-efficacy in their study comparing teacher pre-service programs in Turkey and the USA. Cakiroglu et al. specifically studied the differences in self-efficacy between these two countries. While there were some differences, the desired outcomes were the same. They feel that, "It is conceivable that the successful implementation of science education programs may depend on teachers' self-efficacy beliefs, that is, their personal beliefs regarding their ability to teach science and their ability to produce positive outcomes in science for students" (p. 35).

Cakiroglu et al. (2005) go on to said that while there were many similarities in the self-efficacy of pre-service teachers from both countries, there were some subtle differences. They said, "Pre-service teachers in Turkey had significantly higher beliefs on themselves for welcoming student questions about science or being able to answer

students' science questions" (p. 37). They go on to say, "Pre-service teachers in USA, on the other hand, had stronger beliefs in themselves to be able to help students with difficulties in understanding science" (pg. 37).

In researching teacher self-efficacy, Ginns, Tulip, Watters, and Lucas (1995) conducted a study using a longitudinal study of 72 pre-service teachers starting from when they entered the three-year program until they graduated. A self-efficacy pre-test was given to the students at the beginning of the program and a post-test at the end. There were two components used to measure self-efficacy of these teachers, namely science knowledge and methods of teaching. They stated that:

The findings of this investigation have a number of implications for the pre-service and in-service preparation of teachers, and the administration of science teaching in elementary schools. It is recognized that pre-service teacher education science courses have traditionally not proved to be successful at improving students' sense of science teaching efficacy, yet, attitudes to science and consequent teacher behaviors may arise because of teachers' beliefs about their ability to teach science and children's ability to learn science. (p. 397)

Ginn, et al. (1995) go on to say:

As predicted by self-efficacy theory, any negative beliefs that students hold about science and science teaching may have developed as a result of exposure to unsuccessful or unsatisfactory experiences in their own learning of science, therefore teacher educators need to be cognizant of the importance of self-efficacy and the evidence that students' beliefs can be changed. To this end teacher educators might take into account students' personal beliefs about science and

science teaching when planning and implementing science courses. Inclusion of relevant, positive science experiences specifically designed to enhance students' sense of science teaching efficacy may prove to be an effective strategy, especially if students are encouraged to engage in critical reflection and self-analysis concerning the development of both aspects of science teaching self-efficacy. (p. 398)

In an effort to devise ways of assisting pre-service elementary school teachers to become more comfortable in their delivery of science lessons, Varma and Hunuscin (2008) conducted a study whereby they established field-based experiences in which their pre-service teachers would be involved. They were trying to furnish these pre-service elementary teachers with teaching methods that might actually be contrary to the way they were taught science in the past. These opportunities were furnished by school or district science specialist who felt the importance of science being taught as a specific class within the elementary classroom or in science classrooms. The study consisted of 24 pre-service elementary school teachers being sent twice a week for fifty minutes to a classroom where a science specialist was conducting science lessons. This was part of a methods class required in their educational program. One of the components of the program that these participants reported from their experiences was the serious lack of time for these science specialist to teach and evaluate the lessons they taught. These experiences gave the participating pre-service teachers a better understand of the time involved with presenting any science lesson at the elementary school level. Even though they understood that since time is of the essence while teaching all the various subjects in the elementary school's curricula, many teachers attempt to tie science into the other

disciplines they must teach. Examples might be teaching science during reading class time or social studies class time.

Varma and Hunuscin (2008) mentioned many disconcerting figures throughout this study that reflect on the present status of elementary school science teaching. They state such things as, only 30% of elementary teachers feel comfortable teaching science and that only 40% have taken four or fewer semesters of science in college. These researchers state that today, approximately 12-15% of elementary students receive their science instruction from science specialist or from science specialist along with their regular teacher. They feel that this is a stop-gap measure while many needed changes take place in the science methods classes required to be taken in the undergraduate teaching programs. One of the positive results of this study was that the participants had a chance to make comparisons between classrooms they observed that used a traditional approach for teaching science and the ones that used more of a progressive inquiry-based approach. The participants felt that whichever approach was used, time was still a major stumbling block for the teachers they observed.

The problem with new elementary teachers having to teach science in their self-contained classrooms along with other subjects that many feel are more important, seems to be somewhat universal. For example, Appleton and Kindt (2002) conducted a study of 20 recently graduated elementary school teachers. These teachers were selected from rural and urban schools and were graduates of Australia's Queensland Central University with high honors. Case studies were conducted with these new elementary school teachers focusing on five components of their science teaching. The five components were, activities (ones the teacher felt comfortable in teaching), personal choice of

curriculum, school's priority of teaching science, resources availability, and collegial support. The two components that these researchers felt gave the most input into their study were, safe activities and collegial support.

The teachers in Appleton and Kindt's (2000) study developed their self-efficacy in a manner similar to the way that "kit using" teachers do today (discussed later in Chapter II), just on a smaller scale. These teachers developed their small "kits" consisting of science activities that they have been successful with in their undergraduate work or have received from their colleagues at their school. When they worked through these activities, they became more comfortable and the emphasis switched from a teacher centered focus to a student centered focus. The other successful component of this study was collegial support. It showed that the teachers with the greatest collegial support were the ones that gained their self confidence in the classroom the quickest.

Appleton and Kindt (2002) summarized their research by saying:

From this study, we have learned that teaching science for these beginning teachers was not just an extension of their feelings of confidence in teaching science, or how much science they had studied at school or university. While these personal factors contributed to the teachers' classroom practices, teaching science was also very much embedded in their own development as teachers. This was a complex process where their own personal experiences in science, their views of themselves as science teachers, the school policy and ethos, school curriculum and resource management, and collegial support all played a complex role. Not unexpectedly, those teachers with clear self-perceptions of themselves as teachers and as teachers of science more quickly established workable

teaching practices in science, and were able to progress to thinking about their pupils and the learning in which they were engaging. Those teachers with less clear self-perceptions tended to limit their early teaching practices to a few subjects and strategies which they considered to be safe. Extending their developing self-image as a teacher to include teaching science required further specific triggering events and the support of colleagues. (p. 58)

Howitt (2007) conducted a study to see what some of the factors are that might contribute to elementary school teachers lacking confidence in teaching science. Her study addressed why she felt elementary school teachers will avoid teaching science when possible. In her research to possibly identify what factor or combination of factors involved in teaching elementary school science contribute to a uncomfortable teaching environment for these pre-service elementary school teachers, she interviewed 28 pre-service elementary school teachers about their comfort in teaching elementary school science. She addressed six major factors that she felt might influence these teachers' confidence in teaching elementary school science. These factors were: (1) practice, (2) teacher educator, (3) pedagogical content knowledge, (4) learning environment, (5) assessment, and (6) reflection. The research participants were asked to rank these six factors from most important to least important in affecting their confidence in teaching elementary school science. After analyzing her data, her research showed that no one component was the cause of the lack of confidence but a combination of all six to one extent or another.

All of these researchers have suggested different ways to improve the elementary school teacher's comfort level in teaching science. These aspects have been found

ranging from what psychologists think about developing teachers' self-efficacy to making changes to the teachers' pre-service programs.

In addressing teacher's pre-service programs, Kind (2009) is another researcher who thinks that teacher's pre-service programs needs changing. He stated that:

...the most significant confidence for teacher candidates may be their ability to construct and deliver on effective science lessons focusing on the selection of appropriate classroom strategies based upon a pedagogical framework for guiding the planning and teaching of students' science learning experiences. (p. 1558)

The importance of this statement reflects upon the need for pre-service elementary school teachers' programs to contain components which can provide this needed framework for guiding, planning and delivering good science to elementary school students.

In an attempt to find the best way to assist elementary school teachers to feel comfortable in teaching science in their elementary school classrooms, Bergman and Morphew (2015) suggested another angle similar to the ones suggesting changes in the science methods class like Santau (2014) and Tosun (2000). They suggested adding science content classes to the pre-service teacher's undergraduate program. They said,

To improve elementary teachers' science preparation, the teacher education program at a large Midwestern university created a new science content course, titled Physical Science in the Elementary Classroom (PSEC). This class is worth four credit hours and is required of all undergraduate elementary pre-service teachers. The PSEC course has a twofold purpose: (a) to educate pre-service elementary teachers about fundamental physical science concepts through a

hands-on application setting and (b) to model for these future elementary teachers the instructional strategies and activities necessary for promoting inquiry-based science learning in the classroom. (p. 74)

When discussing this required class, Bergman and Morphey (2015) reported that the results from the pre-service elementary school teachers demonstrated a significant increase in the participants' self-efficacy and outcome expectancy of teaching science in an elementary school classroom.

Bursal (2008) conducted a study of Turkish pre-service elementary teachers and their beliefs about their teacher efficacy and anxieties about teaching elementary school science. He points out that this problem of teaching a subject, such as science of which you are not comfortable, is a universal happening.

The study conducted by Bursal (2008) consisted of 154 Turkish elementary pre-service teachers in three science methods classes. These classes were all taught by the same professor and covered the same material. These teachers were juniors in a four-year undergraduate teaching program in a mid-sized Anatolian University. Prior to this science methods class, each individual had taken 3 credits in biology, chemistry and physics along with 2 credits in environmental science and science laboratory. Surveys were used before and after the class. Bursal attended 60 two-hours classes and recorded his observations. Later these observations were cross-referenced with the surveys. The methods classes were mainly teacher-centered and consisted of weekly science experiments.

Bursal (2008) concluded that the main reason for the lack of teacher self-efficacy was the format in which their previous science classes were taught by professors from the

natural science department. He felt that these teachers needed more time to do experiments and hands-on activities and the only place where that fit was in their science methods classes. He stated that:

Based on the findings from this study and the previous research, Turkish teacher educators should consider enhancing the effectiveness of science methods courses by: - Incorporating student teaching activities at elementary schools into science methods courses and – Employing more hands-on science inquiry activities – activities relevant to everyday life and can be used directly in elementary classroom – via student-centered teaching methods. (p. 107)

In continuing the discussion about modifying pre-service teachers' methods programs, Kelly (2000) added her research. She states that science education reform has been implemented over the past four decades where most of the emphasis has been on curriculum reform and not on how to prepare our future elementary school teachers during their undergraduate years. She focuses her research on how to enhance these pre-service experiences.

Kelly (2000) conducted her research on a group of junior and senior education students who needed a science methods class to complete their program. Over 200 students have completed this methods class over a 4 year period. The class was designed with two components, namely a formal component and an informal component. The formal component was the university classroom and the informal component was the local museum of science and history. The classroom provided a place for conversation and meaningful science experiences. The museum provided an informal place rich in investigative opportunities for hands-on science. Data for the study was collected from

pre-course and post-course surveys asking for the participant's attitudes about teaching science, confidence in teaching science and their understanding of pedagogical strategies. Data was also collected on content knowledge, respective presentations, and interviews. A constructivist classroom design was used in this study whereby both content and process were considered equally important.

Kelly (2000) goes on to explain that,

In the science methods course, pre-service teachers are considered participant-observers because they experience science through investigations, both individually and in groups: they question and reflect through discussion, journals, and further explorations; and in the process, build and modify their own understandings and explanations of science. (p. 760)

This methods course provided the pre-service teachers the opportunity to play the roles of both student and teacher. The student role involved learning science concepts in the classroom, conducting experiments at the museum and from watching other teachers presenting their respective lessons. The teacher role involved developing lessons and experiments for the other students to complete. Discussions involving both roles were conducted among the pre-service teachers. Kelly (2000) stated that, "this course was based on the premise that pre-service teachers can gain important understandings about learning and teaching by being encouraged to be both learner and teacher and to reflect on their experiences in both roles" (p. 770).

Kelly (2000) concluded her study by stating:

The success of the course described here adds to the growing body of evidence

that suggests that even a single science methods course based on a holistic, constructivist approach can reform and enhance teacher knowledge, confidence, and attitudes and may lead to the utilization of constructivist strategies in teaching science in the elementary science classroom. As such courses become more common, it is reasonable to expect positive changes in the teaching of elementary science. (p. 772)

I found that in this section, there have been many different studies performed to investigate how possible changes in pre-service methods classes could lead to a more self confident elementary school teacher while teaching science. And all of the studies point to the fact that if these pre-service teachers have a chance to witness, or participate in inquiry-based structured methods classes, they can become better at comfortably teaching elementary school science.

Need for a Strong Science Background

In this section, I examine the literature as to how much science background content knowledge an elementary school teachers need in order to feel comfortable in teaching science in their classrooms. This comfortable feeling is reflected as a teacher's self-efficacy.

Another component of teacher self-efficacy in teaching science deals with the number of science classes a pre-service teacher has had, which reflects a strong or weak science background received in their undergraduate studies. Researcher are searching for an answer to the question of how is it possible to make elementary school teachers more comfortable in teaching science when many of them have a poor background in the sciences. There are a number of leaders in science education that answer that question

with the response that if pre-service teachers should take more core science courses in their undergraduate work, they would feel more comfortable in teaching it. While this might seem to be common sense, a growing group of educators of educators who are not sure about this suggestion and are looking for other answers for this problem. In Appleton's (1995) research, he made the following comments about this problem which plagues many elementary school teachers. He wrote,

In recent years there has been renewed concern expressed about the state of science teaching in many primary and preschool (elementary and kindergarten) classrooms, and the poor science background knowledge of many teachers. The teachers' lack of confidence to teach science has been largely attributed to their poor background knowledge. A reaction from teacher educators, such as recommended by the Australian *Discipline Review of Teacher Education in Mathematics and Science Report*, has been to provide more explicit science discipline units in pre-service teacher education courses. However, a few studies have cast some doubt on the notion that more science discipline studies help pre-service teachers become more positive about teaching science. This paper reports on pre-service students' perceptions of their confidence to teach science before and after a science education unit which included only a small amount of physical science, and took an explicit approach emphasizing the students (pre-service teachers) as learners. These factors, other than the study of more science content, influence student teachers' confidence to teach science were substantiated. (p. 358)

Other science researchers support Appleton's beliefs. Skamp (1989) conducted a study of two groups of undergraduate students. The first group was composed of students majoring in science. The second group was made up of pre-service education students. For one semester, both groups took two units in science pedagogical studies and two units in basic science classes. Two evaluation tools were used in this study. One measured the participants' attitudes towards science and the second one measured their attitudes about science teaching. At the initiation of the study, both groups had positive feeling toward science and neutral feeling about teaching science. At the end of the study, the attitudes toward science did not change in either group, but the attitudes toward teaching science increased significantly with the pre-service education students.

Fleury and Bentley (1991) discussed the importance of the teacher and his or her qualities and strengths in the field of science that contribute to student learning. With this in mind, they introduce the thoughts of Yager (1989) who "... argues that of all the elements involved in a school's science program, teachers are the most crucial components for student success in learning science" (p. 33). Stake and Easley (1978) stated that many elementary school teachers lack a strong background in the sciences which can appear in the elementary school science curriculum.

Many authors of research talk about the "Nature of Science." This differs from just having core scientific knowledge and is considered to be the most important component in the undergraduate pre-service teacher's science education. When defining the "Nature of Science," Fleury and Bentley (1991) stated:

The concept of the "Nature of Science" is a foundational and important part of the knowledge base for teaching science. It deserves particular attention in science

education at all levels because it is a global conception that frames one's total scientific knowledge. (p. 58)

When speaking of the "Nature of Science," Fleury and Bentley (1991) go on to explain how the "Nature of Science" is like the infrastructure of a city or building upon which other things can be build; in this case, the knowledge of science. Along with this idea, these authors have also emphasized the importance of getting students to learn the "Nature of Science" in their elementary school classes but feel that this has been severely lacking in most elementary school science classes.

These researchers' findings are significant because of the importance of having good pre-service teacher experiences related to better understanding science which will be conveyed to their students in the future. Fleury and Bentley (1991) concluded their study by saying:

The content and methods of instruction should reflect these issues about the "Nature of Science" and should not promote fallacious forms of reasoning. But just as "conceptual change" theory has been important in helping students to develop more sophisticated scientific concepts, understanding pre-service teachers' alternative conceptions and misconceptions about the "Nature of Science" is a necessary first step in modifying science teacher education. (p. 65)

Throughout this section, science teacher self-efficacy along with the "Nature of Science," methods classes and the amount of core science knowledge elementary school teachers need are discussed. The primary emphasis of this section is on the latter.

For many years, many elementary school teachers have faced the uncomfortable situation in teaching science because of a lack of background in the subject area. Not

only are they uncomfortable about teaching science, they have a number of other classes to teach throughout their busy school day. For those who really do not understand what is required of an elementary school teacher today, Davis and Smithey (2009) from the University of Michigan clearly explained what these duties are by saying:

Teaching science can be a challenge, especially for beginning elementary teachers. Most elementary teachers teach multiple subjects including language arts, mathematics, social studies, and science; some also teach other subjects such as art, music, and computer literacy. Within the subject of science, elementary teachers face further challenges, since at the elementary level teachers are responsible for life science, physical science and earth science - and they are expected to teach these through engagement in authentic scientific practice. Beginning elementary teachers thus require many areas of mastery, yet generally lack both sufficient coursework and experience that would contribute to their knowledge base for helping children develop coherent knowledge of science concepts and practice and thus become scientifically literate citizens. (pp. 745-746)

Appleton (2002) conducted a study to see what methods of science instruction worked the best for these elementary school teachers who possessed a low amount of science core knowledge. He stated that prior to today's innovations in teaching elementary school science, many teachers used what was called, "science activities that work" (p. 393). Appleton conducted interviews with 20 teachers to better understand what this term meant. He stated that,

Themes that emerged suggest that activities that work are hands on, are interesting and motivating for the children, have a clear outcome or result, are manageable in the classroom, use equipment that is readily available, and are preferably used in a context where science is integrated into themes. (p. 3)

In search for the answer of how much science does an elementary school teacher need to feel comfortable in the classroom while conducting inquiry-based science lessons, Dobey and Schafer (1984) conducted a study involving pre-service teachers from three different groups based upon their knowledge of science concepts. The first group consisted of pre-service elementary school teachers with a minimal amount of science content knowledge. The second group consisted of pre-service elementary school teachers with a sufficient amount of science content knowledge. And the third consisted of pre-service elementary school teachers with a substantial amount of science content knowledge. In this study, not only was the quantity of scientific knowledge questioned, but also these teachers' abilities to teach using inquiry-based instruction. Therefore the combining of these two variables was the true feature of this study. The case study consisted of 22 pre-service teachers who were given a pretest and posttest on various science concepts after teaching an inquiry-based lesson (explained later in Chapter II) on the material.

Prior to the study, Dobey and Schafer (1984) acknowledged other researchers, (Blosser & Howe, 1969; Karplus & Their, 1967; McDermott, 1976; Suchman, 1976; Victor, 1974), and their thoughts about the need for a sufficient quantity of basic scientific knowledge to do inquiry based elementary school science. Dobey and Schafer summarized the results of these researchers' studies by saying, these researchers

feel the inquiry teacher has an obligation to be knowledgeable about the concepts and conceptual schemas that will emerge as science inquiry progresses. Teachers must be scientifically knowledgeable if they are to provide the guidance necessary to yield profitable experiences and produce desired concept attainment. (p. 39)

Dobey and Schafer (1984) go on to address the pre-service teachers who do have that sufficient quantity of science knowledge but may not be able to use inquiry-based science instruction. They say that other researchers such as Brehm (1968), Kuhn (1973), Perkes (1975), and Ukens (1974) feel that “On the other hand, some science educators suggest that teachers who have science knowledge tend to exclude inquiry and instead stress their knowledge to the extent that their sole purpose is to drill facts into the learner” (p. 39). And lastly, there are those researchers who feel that a minimal knowledge of science may be best for the teacher and their students because they can use inquiry based science instruction to learn the science concepts together.

Lastly, Dobey and Schafer (1984) stated that,

The results of this study revealed that teachers with more science content knowledge were also more confident and self-assured in their teaching. Perhaps by helping teachers acquire more of the science knowledge needed for teaching children, teachers will develop more confidence in teaching science, will teach more science, and will develop the security necessary for dealing with the uncertainties of inquiry teaching. (p. 49)

Ucan and Sanalan (2011), who are both college professors in Turkey join the conversation about many of their concerns in preparing pre-service elementary school teachers to teach science. Interestingly, many of their concerns match our concerns that

are found in similar American universities. Educational researchers in the U.S., along with many other developed countries, are always looking for what components of these pre-service teacher programs might be changed for the better to produce knowledgeable and confident elementary school teachers of science. At this time in Turkey's reform process for enhancing their pre-service education programs, they might have felt that more developed countries like the United States were the world leaders in science education reform. I concluded this by the fact that, "A large number of Turkish students were sent to western countries to pursue master's and Ph.D. degrees in educational fields so that they could return to work in Turkish colleges of education after completing their graduate studies" (p. 88).

One of the concerns of Ucar and Sanalan (2011) is how to establish a positive attitude about science while these pre-service teachers are being trained in undergraduate programs. They reference Gabel and Rubba (1979) who stated, "Pre-service teachers who are expected to teach science should learn both teaching methods and science content in these programs. It might be possible to develop a curriculum for pre-service teachers that fosters a positive view about science" (p. 19).

In trying to establish this positive attitude, Ucar and Sanalan (2011) addressed the question of how many science courses these pre-service teachers should have in their undergraduate education programs. At that time, there were two schools of thought about this issue.

Ucar and Sanalan (2011) presented these two schools of thought by reporting the findings of the researchers Butts and Raun (1969) and Douglas (1979) which are:

There is debate over the effects of science courses on the development of positive

attitudes toward science teaching. The existing research reports two conclusions: first, the attitude is related to the number of courses students have taken (Butts and Raun, 1969, p. 101), with negative attitudes toward science being reported by students who have taken more science courses. However, another study (Douglas, 1979, p. 110) found that a positive attitude is related to taking more science courses (Ucar & Sanalan, p. 88).

Ucar and Sanalan (2011) continued in this discussion by presenting the findings of four other researchers, namely, Skamp and Mueller (2001), and Cronin-Jones and Shaw (1992) who have opposing opinions about the forming of teachers' opinions of teaching science. Skamp and Mueller feel that a pre-service teacher's attitudes are formed by the number of good science classes they have had along with their methods of teaching elementary school science classes. Cronin-Jones and Shaw reported that these pre-service teachers' science education programs did not influence the opinions about teaching elementary school science.

In this study done by Ucar and Sanalan, 459 pre-service elementary school teachers were exposed to either the old traditional methods of teaching elementary school science or the new one. As compared to the old method, the new one had more science content classes required while decreasing the science methods classes. The study used a tool developed by Ohio State University and it measured the students' SVAS – students views about science. The results showed that the highest scores on the SVAS reflecting a positive attitude about science were scored by the students who believed that lowering the requirements for more core science content classes would be best as prescribed by the old methods.

This study is important in the discussion of how to best prepare pre-service elementary school teachers because it points out some of the feelings of these students about their colleges or universities requiring them to have a sufficient number of core science classes before graduating. It also helps tie together some of the feelings found in the debate over what constitutes an excellent pre-service elementary school teacher program.

The debate over the problems elementary school teachers have in teaching science continues. Throughout the years, many elementary school teachers have had to develop their teaching plans to accommodate science teaching in the elementary classroom. Studies such as ones performed by Howitt in 2006 and in 1995 to name a few, discuss the difficulties many of these teacher experience due to either a poor background in science core content or the inexperience of teaching elementary school science using an inquiry-based method. Ginns and Foster (1983) explained the importance of a positive attitude about learning science in a study they performed on nearly 500 pre-service teachers in a science methods class at the Brisbane College of Advanced Education in Brisbane, Australia. They communicate their suggestions for pre-service teachers by providing a quote from Gabel et al. (1977) which states “...that helping teachers to acquire a positive attitude to science and science teaching is a desirable outcome of any science course” (p. 503). Gabel et al. go on to say that:

... a number of factors must be accounted for when planning suitable science courses for pre-service elementary teachers. Any course should contain suitable hands-on activities, utilize an inquiry teaching strategy, and develop or improve attitudes to science and science teaching. (p. 504)

This study of Ginns and Foster (1983) attempted to determine the difference between males and females and their attitudes on learning science using a lecture approach or using an inquiry teaching strategy called a topic approach with many hands-on activities. The results showed that the males obtained higher positive gain scores for attitudes under the lecture approach, while the females in this condition obtained more positive gains in the inquiry-based teaching.

Ginns and Foster's (1983) study is important because it addressed the techniques by which pre-service teachers should be prepared to teach science. Interestingly, the study showed that the males actually enjoyed learning science via a lecture format while the females like learning it through hands-on inquiry based lessons. Also, more than ninety percent of the subjects were females and a great number of elementary school teachers are females as well. The U.S. Department of Education reported in 2008 that the percentage of female teachers in the United States is 76%. (U.S. Department of Education, 2013)

The number of science classes a pre-service teacher should have along with pre-service teacher methods classes were examined in a 2005 study by three researchers. Laera, Moyer and Everett (2005) studied 234 students in an elementary school teacher program. These subjects were exposed to several new methods classes which involved inquiry-based science teaching. There were also students in this study that had yet to be exposed to these new methods classes. They were graded on their ability to develop and deliver their science inquiry-based lessons. These students had different levels of science content knowledge which possibly played a role in each student's success. They stated that:

The data show that there is a relationship between the type of science content knowledge and the ability to design an inquiry lesson. Students who had not completed any of the newly reformed inquiry science classes were not as a group as competent on writing inquiry lessons as the group of students who had completed one or more inquiry courses. We believe that this is because students had experienced inquiry for themselves, many for the first time. Scientists who taught the inquiry courses modeled teaching as facilitating scientific understanding rather than teaching as giving out facts and information. (p. 21)

Tosun (2002) continued the discussion relating the number of science classes a pre-service teacher should have along with pre-service teacher methods classes. He addressed the beliefs of pre-service elementary teachers toward science and science teaching. The importance of requiring these pre-service elementary teachers to take more science courses is questioned. It addresses the fact that even though these teachers took a considerable amount of science classes in high school, their willingness to do the same in college was very poorly recorded. All in all, many of these students had very low opinions of science in general and had little interest in teaching it. One result of Tosun's study was that the feeling about teaching elementary school science did not change even after taking their science teaching methods classes. This study suggested that the traditional science methods classes should provide a different approach to teaching science which would hopefully lead to an increase in self-efficacy.

Santau, Maerten-Rivera, Bovis, and Orend (2014) are researchers who do not necessarily feel that "more (science classes) is better." They feel that just adding more science content requirements to a student in an elementary school teacher program is not

that productive in having elementary school teachers who are comfortable in teaching elementary school science. There are also advocates, like Tosun (2000), for changing the science methods classes to meet the needs of the pre-service teachers and eventually their students. A science knowledge exam was administered before and after the pre-service teachers participated in a newly developed science methods class. The initial content test showed an understanding of fairly simple science concepts while the content test administered after the class showed a greater understanding of more complicated science concepts, especially on the content which was used to teach the methods class. Based upon the results of this study, more efforts are being utilized to investigate and further develop the finding of this study.

In the research of the literature on how many undergraduate science classes a pre-service teacher should have, I found that there are a number of different beliefs about this question. It is definitely understood that an elementary school teacher needs at least a sufficient amount of science core knowledge to feel comfortable teaching the subject. There were some researchers who felt that the more undergraduate classes a pre-service teacher has taken, the better science teacher he or she would be. But, there are others who feel that having a good science background is a detriment because these teachers do not use inquiry-based instruction as it is meant to be used, but just try to fill their students with the core science knowledge they have. In general, the research reflects that most pre-service elementary school teachers did not necessarily like science in high school and made that evident by taking only the minimal required science classes in college.

Roadblocks to Implementing Good Science Teaching

In this section, I researched some of the problems an elementary school teacher has in making a good effort to teach science. These researchers addressed the many aspects of being a typical elementary school teacher.

In the discussion of the various factors hindering an elementary school teacher from being comfortable in teaching science such as, teaching time or prior pre-service training etc., some factors considered as outside roadblocks should be included. Even though the fact that science had been generally accepted across the country as a subject that should be included in all elementary school curricula, Lee and Houseal (2003) addressed how this could possibly be done in an already full curriculum that each elementary school teacher encounters on a daily basis. They stated:

The focus on changes in elementary school science has shifted from teaching it at all to its role in the curriculum, the amount of time devoted to it, and to changing instructional practice. Sources of change in teaching elementary science are internal arising from the desire of teachers to alter practice or external, such as mandated standard, benchmarks and curricular framework, emphasizing inquiry teaching and authentic assessment strategies. The National Science Education Standards (National Research Council [NRC], 1996) and local and state standards and benchmarks have created curricula packed with content as well as suggested pedagogy and assessment. Just as these internal and external factors influence change in science teaching, so too are there multiple barriers or impediments to teaching elementary science. (p. 37)

Lee and Houseal (2003) go on to discuss these multiple barriers or impediments by saying:

The literature is rich in studies on the factors that constrain teaching elementary school science. These can be divided into two general categories: (1) external and (2) internal factors. External factors include time; money; supplies; materials and equipment; classroom management; dealing with diverse learners and individual differences; and support from colleagues, administrators, and the community. Internal factors include content preparation, self-confidence levels, anxiety, attitude, and professional identity toward teaching science. (p. 37)

This research was a qualitative study of several select elementary school teachers who had different views about adding science to their daily routine of teaching elementary school students. Both the external and internal factors were discussed with each teacher.

The interesting findings from this study were that many of the encountered obstacles of teaching elementary school science were seen across the board of these teachers' responses during their interviews with the researchers but two new ones were added to the traditional list. Lee and Houseal (2003) said, "Though this case study does not elucidate any solutions to the constraints of teaching elementary school science, it definitely adds standards and benchmarks to the list of constraints and shows the interrelations of self-efficacy to many of the constraints" (p. 53).

In this section, the literature showed that there is indeed a tie between teacher self-efficacy and their pre-service undergraduate college program. It also showed that is truly a need in many science pre-service programs to introduce inquiry-based instruction

which can ease the concerns many elementary school teachers have. Further, the idea that the more undergraduate science classes a pre-service has, the better he or she will teach science was discussed. It was found that this theory is not true in most cases. And lastly, the subject of roadblocks to implementing good elementary science education reflected true problems that the teacher have to deal with on a daily basis. These include, (1) more classes to teach, (2) less time to do so, (3) standards and benchmarks to achieve, and (4) local and state exam requirements for accountability.

In this section, I found that most elementary school teachers have somewhat of a juggling act to perform on a daily basis. This is because they have some many different subjects to teach and a limited time to do so. In many schools, teaching science does not appear to be a priority as compared to teaching reading, writing and mathematics. There were also outside roadblocks mentioned by these researchers that make an elementary school teacher's life more difficult. Some of these roadblocks involve teacher evaluations and required student preparation for local and state standardized tests. And to make things more complicated, the results on these mandatory tests are then reflected in a teacher's and school's evaluation and accountability.

Inquiry-Based Instruction

In this section, I research both the components involved with inquiry-based instruction and then, the importance of inquiry-based instruction in teaching elementary school science successfully.

Abe-El-Khalick et al. (2004) discussed the term "inquiry" and the manner in which it has been used over the past 50 years. In many ways, the term "inquiry" has been used to show dissatisfaction with the routine ways of teaching science. When one closely

examines the term “inquiry”, they will find that most people believe that it reflects the current (NOS) “Nature of Science.” These authors go on to say,

An undercurrent theme in these conceptions is advancing and distinguishing between inquiry as means and ends. “Inquiry as means” (or inquiry in science) refers to inquiry as an instructional approach intended to help students develop understandings of science content (i.d., content serves as an end or instructional outcome). “Inquiry as ends” (or inquiry about science) refers to inquiry as an instructional outcome: Students learn to do inquiry in the context of science content and develop epistemological understanding about NOS and the development of scientific knowledge as well as relevant inquiry skills (e.g., identifying problems, generating research questions, designing and conducting investigations, and formulating, communicating, and defending hypotheses, models, and explanations). (p. 398)

These authors seem to indicate that presently, the “Inquiry as means” is the more popular and familiar form of inquiry-based teaching in elementary schools. They also indicate that “Inquiry as ends” deals more with NOS and should be emphasized in teachers’ pre-service programs and once understood at that level, will flow over into their teaching in the classroom.

Warner and Myers (2011) from the University of Florida discussed inquiry-based instruction when addressing educators approach to teaching techniques. They stated that educators should always be evaluating and searching for better ways of meeting the educational needs of students and society in general. They continued their discussion by stating that there is a continual emphasis on this issue by federal, state and local officials

emphasizing the importance of educational reform in science, math, reading and writing. They promote the use of inquiry-based teaching in attempting to accomplish this effort.

Since inquiry-based instruction is the backbone of kit usage in teaching elementary school science and a major component of my research study, an understanding of exactly what makes up inquiry-based instruction is very important.

Warner and Myers (2011) defined inquiry-based teaching as:

Inquiry-based teaching is a teaching method that combines the curiosity of students and the scientific method to enhance the development of critical thinking skills while learning science. As learners encounter problems they do not understand, they formulate questions, explore problems, observe, and apply new information in seeking a better understanding of the world. The natural process the learners follow when seeking answers and deeper understanding closely follows the generally accepted scientific method. Often, the answers proposed by learners lead to even more questions—much like the outcomes of research. (p. 1)

Many suggested changes to teacher education programs have been initiated as discussed earlier in Chapter II. Over the past three decades, others have promoted the importance of using inquiry-based instruction, many by use of what is known as a “science kit” program as investigated in my study and explained later in Chapter II.

Minger and Simpson (2006) conducted a study to investigate the possible change in pre-service teachers’ attitudes about teaching elementary school science. They felt that this research was important because attitudes about science not only deal with the teacher but also their students. They say, “Teacher attitudes have an influence on student

attitudes toward science and, therefore, the science education community should pay greater attention to factors that positively impact teacher attitudes” (p. 49).

This study conducted by Minger and Simpson (2006) was an extension of ones performed by Hall (1992) and Kramer (1979, 1988) which involved the requirement for all pre-service teachers in a college to take a biology class to better understand not only the content, but more importantly, the activity based, hands-on delivery system. This course was similar to the previous one used in the aforementioned research but was enriched with additional teaching techniques and lengthened from a one quarter class to a full semester. Attitudes were measured with a pre and post survey. The results showed an increase in attitude attributes throughout the survey with the exception of the “time to set up labs” which showed a negative trend. Therefore, after seeing the results of this study, it appears that the use of time in teaching hands-on science should receive further study.

As mentioned in Chapter I, Sullivan-Watts et al. (2013) addressed the use of science kits in teaching elementary school science. In this study, the science kits were used over a two-year period with twenty- seven pre-service elementary teachers and consisted of an evaluation system for teachers in three categories. The first group had use of the science kits for the two-year period. The second group had the use of the science kits for one of the two years and the last group did not have access to the science kits. When these researchers evaluated the data from their study, they found that the group that utilized the science kits in their science lessons the longest, performed the best; receiving the highest scores for the teachers and their students.

When addressing the use of inquiry-based teaching by use of science kits, the

question of, how much core science knowledge does an elementary school teacher need to successfully implement this style of teaching, once again is raised. Along these lines, Luera, Moyer, and Everett (2005) stated:

Although various governmental and professional organizations recommend that teachers use an inquiry-based approach to science education, most teachers do not use this pedagogy. Lack of content knowledge and/or insufficient skills in planning inquiry-based lessons may contribute to teachers' reluctance to utilize this methodological approach. (p. 12)

These authors go on to say, as earlier addressed in this Chapter II, that: "Previous work indicates that increased science knowledge leads to greater confidence and better enactment of inquiry. Adequate science content knowledge guides the planning of an effective inquiry lesson" (p. 15).

Contrary to the beliefs of Luera et al. (2005), Flick (1990) reported his more positive findings. He conducted a study involving 80 pre-service elementary school teachers who were enrolled in a teaching methods class to determine the pros and cons of using inquiry-based science teaching. He used two groups of teachers, one using an inquiry-based presentation and one that did not. In the inquiry based science teaching group, each teacher worked with one child and measured his or her interest levels in learning the science topics over the semester. The second group of teachers worked with one student as well but presented the same science concepts in other classes which were taught in a traditional manner. Teacher satisfaction was measured with a pre-test and post-test. The teachers using the inquiry-based techniques scores significantly higher on

the post-test reflecting teacher and student interest in inquiry-based science teaching and the learning related to this type of teaching.

Colburn (2000) professed that the use of inquiry-based instruction is not a “one size fits all” method of teaching. In Colburn’s primer on how to conduct inquiry-based instruction, he stated that students and teachers will be even more successful if they approach inquiry-base instruction slowly until both the teacher and students are comfortable with this teaching mode. He also pointed out that there is no such thing as a “teacher-proof curriculum” and stated that, “It’s up to you to find the right mix of inquiry and non-inquiry methods that engages your students in the learning of science” (p. 44).

For decades, there have been discussions about the use of textbook teaching versus inquiry-based instruction. Foley and McPhee (2008) stated that,

Research shows that inquiry-based curriculum materials, in comparison with traditional teaching methods, work better to help students engage in, reflect on, and apply scientific knowledge and science process skills and perform better on assessments than traditional methods. In addition, students in classes where science is taught using hands-on methods are generally more favorable to science and have a better understanding of the “Nature of Science” than students in textbook classes. (p. 1)

Inquiry-based instruction leaves room for teachers to modify its basic structure by adding or subtracting various components to the curriculum. These changes need to be done by intelligent and exciting teachers. As pointed out earlier, these problems with teaching science in elementary school are not limited to the United States, but are universal.

Milne (2010) detailed some of the problems in New Zealand with science education. He stated that the level of interest in science found in the secondary grades has dropped considerably. They also said that this decrease in interest in taking the normal science classes are seen between the 4th grade and the 8th grade. The kids complain that what they do in class is not interesting and that they are bored. At the same time, these kids do express a sincere interest in science and want to learn more. Therefore the authors pointed out the importance of the science curriculum to change reflecting more time spent on investigating and exploring content that are relevant to the student's life.

Milne (2010) suggested that the importance of investigating and exploring science topics is not well managed in most elementary school classrooms. He thought that what is really missing is the “WOW” factor or what he called the “aesthetic experiences of natural phenomena” (p. 102).

In conclusion, Milne (2010) stated the following:

... “creative exploration” is an approach to teaching and learning that models many aspects of scientific inquiry. It requires an exploratory phase that essentially provides the children with rich learning experiences about phenomena. Out of these aesthetic experiences, authentic questions can be generated that the children can investigate to create and test theirs and others explanations. It requires enthusiastic teachers who personalize the science activity and not only provide support for, but also challenge the children's thinking as they develop and share their explanations. They support the children as they move their creative thinking from children's science to the creative world of scientists. (p. 112)

Researchers know that when a teacher attempts to use inquiry-based instruction, sometimes it is difficult because they cannot decide upon what order the instructional instrument should be used. Along with this, the level of understanding of the students need to be taken into account. The teacher needs to know if their students are still concrete thinkers or have moved into abstract thinking.

Marshall and Horton (2011) conducted a study of a group of science and math teachers attempting to implement inquiry-based instruction in their classrooms. Over 100 observations were performed. They were basically trying to find in what order instruction components should be used. The two components were exploring concepts and receiving instruction on the topics at hand. They found several correlations between which component came first and student understanding. In the classes where exploration was used first, there was a higher correlation between the time spent on exploration and higher cognitive levels of thinking. Also, they found a negative correlation between the time spent explaining the material and the cognitive levels of thinking.

Marshall and Horton (2011) stated that there was a significant difference in cognitive levels of thinking depending upon which order of instruction was used. But, they also stated that these findings were only for the order of instruction and the remainder of the components of inquiry-based instruction had no difference between the two groups of classes. They suggest that using professional development time would be a good way to train these teachers the proper order of instruction. They continue to say,

When the goal is not deeper understanding but rather a focus on lower cognitive level skills, such as automating a certain procedure, then exploring first may not be helpful. However, whenever the goal is to push toward deeper understanding,

then teachers may be well advised to allow students ample opportunities to develop a plan, observe and collect data, and try to determine the underlying constructs. (p. 99)

Lastly, Marshall and Horton (2011) stated that it might seem counterintuitive when observers see, when there is more time devoted to explanation, cognitive levels decrease and when more time was given to adequately investigate the problem, cognitive levels increased.

Along with determining the order of instruction, Krajcik, Blumenfeld, Marx, Bass, and Fredricks (1998) conducted a study of eight middle school students who were attempting to do inquiry-based projects in their science classrooms. The study involved two seasoned teachers who had college degrees in science. Each teacher chose four students to include in their study. The students observed by the teachers were of average intelligence and possessed different feeling about science. These students were videotaped throughout the year long project and were evaluated by the teachers as to the quantity and quality of inquiry-based science content.

Krajcik et al.'s (1998) results demonstrated some strengths and weaknesses of these students being studied. The strengths included such things as; these kids are capable of doing inquiry-based science and doing it with some higher level thinking. The weaknesses discovered by this study involved not necessarily the weaknesses of the students, but more with the planning of the projects. These concerns dealt with the design and sequencing of the science content in these projects and the ability of the teachers to make small scaled projects that reflect larger real-world investigations. They

concluded their study by discussing the scaffolding of the project in order to provide the students with the help they need. They stated:

We need to consider a range of scaffolds from teachers, peers, and technology that can aid students in examining the scientific worth of their questions, the merits of their designs and data collection plans, the adequacy and systematicity of their conduct of the investigation, and the accuracy of their data analysis and conclusions. In addition, we need to find ways to capitalize on the enthusiasm students exhibited to enhance interest in science. (p. 348)

From time to time, an elementary school teacher will take science outside the classroom with the help of other school personnel. Several examples follow.

Harada and Yoshina (2004) discussed the efforts of an elementary school teacher who is learning how to implement inquiry-based science into her classroom with the help of the school's librarian. They say that this teacher was trying to have the kids investigate various animals which were assigned to them. They went to the library and the students looked up information on their respective animal and wrote a short report. Most of the information was just copied right out of the books the kids used. The kids thought that the assignment was easy and the teacher was disappointed with the results of their reports.

Harada and Yoshina (2004) go on to say that the teacher in an attempt to utilize inquiry-based science lessons in her classroom, decided to take the kids on a field trip to the local zoo. The kids loved the field trip and learned as they were having fun. The field trip generated many questions when the kids returned to their classroom. As a group, they decided upon which questions could be used by the entire class of students

and went about answering them. Following this, they made models of their animals in their respective habitats and invited the whole school to visit for presentations. The importance of having the school's librarian involved was emphasized by saying that they have a better understanding of the process from an outside the classroom view.

Lastly, Harada and Yoshina (2004) stressed the important factors needed in an inquiry-based classroom. They mention the following terms: connect - use of previous knowledge; wonder – questions and hypotheses; investigate – find information and evaluate it; construct – new understanding and new hypotheses; express – discuss with others your findings; and reflect – look back at your learning and develop new questions.

Three different types of teachers along with the school librarian assisted in the next example. Chu, Chow, Tse and Kuhlthau (2008) conducted a study involving 141 fourth graders in a Hong Kong elementary school. The study was conducted over two 10 week periods. The first one involved doing a study and project on the subject of the earth. The second part involved the history of the Orient. The students were from a general studies class but were using the inquiry-based instruction to complete their projects. They were assisted by the general studies teacher, the school librarian, the language teacher and the IT teacher.

In discussing the results of this study, Chu et al. (2008) stated,

This study showed that a collaborative approach involving three kinds of teachers and the school librarian in equipping students with the knowledge and skills they needed to conduct IBL (Inquiry-Based Learning) projects more effectively.

Moreover students' various skills and abilities were greatly enhanced in the process to foster students' development in research skills. Our findings suggest

that general studies teachers should take a supporting role as facilitator, advisor, and guide in the students' inquiry learning process. To promote students' autonomous learning through the projects, parents should help their children as little as possible. (p. 35)

Chu et al. (2008) were able to demonstrate by means of this study that inquiry-based education does not have to be limited to science but can be utilized in other classes like social studies and technology.

Other sources of data need to be evaluated as well. Haurey (2001) investigated the possibility of students using inquiry-based science investigations on data sets that cannot be collected in the classroom. He stated that the same inquiry procedure normally used in the classroom can be applied to various data sources throughout the world. He listed a number of data sources such as the EPA (Environmental Protection Agency) and NOAA (National Oceanic and Atmospheric Administration) that can be easily accessed by use of the internet. He also suggested various ways that students from one school could collaborate with students from other schools or research groups located around the world.

Haurey (2001) goes on to define his understanding of inquiry-based teaching by saying:

Though inquiry-based teaching strategies typically engage students in investigations, it is not the physical activity that defines inquiry. Teaching through inquiry is distinguished by its emphasis on a questioning attitude, gathering data, reasoning from evidence, and communicating explanations that can be justified by available data. (p. 1)

And lastly, is there a connection with inquiry-based science teaching and other classes? O'Donnell (2007) discussed the relationship between inquiry-based science instruction and other subjects. She stated that when students have the opportunity to have been exposed to inquiry-based science classes, they do better in science but also in other classes as well. She thinks that the skills learned with hands-on science carries over to other disciplines. She thinks that her findings closely match those of Summerlee and Murray (2010) in carrying inquiry-based science skills to other courses the student might take.

Summerlee and Murray (2010) conducted a study of approximately 100 first year college students and their progress through out their 4 years of college. These students had to participate in one of three seminar courses taught with what they called "Inquiry-Based Learning." The study was conducted to see if these students, after completing their respective seminars would have learned the process skills found in such a class. They wanted to see if the skills learned in the seminar class carried on with them throughout their remaining 3 years. Grades for these students were evaluated and based upon prior classroom success, grade predictions were made for subsequent classes as if they did not participate in this study. These researchers reported that the students in the study showed subsequently, superior academic performance in their remaining classes at the university. They attribute this result to the fact that while the participants were in these initial seminars, they

... truly engaged them in learning and in learning about how to learn. Such an experience builds their confidence, but more importantly, it changes their approach to research and to the use of resources. The experience of IBL (Inquiry-

Based Learning) provides a context for students to develop the skills necessary to cope more effectively with subsequent material presented in traditional formats.

(p. 91)

In this section, I found an accepted agreement on what constitutes inquiry-based instruction and how this type of instruction is best carried out by the use of science kits. Some of the authors also stated their findings about how both teachers and students enjoyed learning science through inquiry-based instruction. In this study, the importance of elementary school teachers learning how to use inquiry-based instruction properly, during their pre-service years, is stressed.

Science Kit Usage and Components

In this section, I researched the literature on what constitutes a science kit and how the components of said science kits can be used in teaching elementary school science.

The encouragement to use science kits in teaching elementary school science has been around for over two decades. Many studies have been conducted to compare the traditional manner of teaching elementary school science to the innovative method of using science kits to deliver inquiry-based instruction.

Blanchard, Dotger, Gardner, Jones and Robertson (2011) conducted a study of 503 elementary school teachers from an urban area in the southeast United States. Eighty- nine of the schools where these teachers worked failed to make adequate yearly progress the previous year. All of the teachers were given science kits to be used in their respective classrooms over a period of one year. They received training on the kits and support from the district. Each teacher had the prerogative to use the science kits as they

saw fit. Some teachers used them quite frequently and others used them sparingly.

Approximately 140 teachers of the total of 503 used the science kits over 50% of the time in their science classes. The teachers that used them infrequently fell into two categories; namely, new teachers and seasoned teachers. These researchers felt that the new teachers were not confident in science teaching already and were more concerned with classroom management and everyday classroom duties. When evaluating the second group of teachers, the seasoned ones, these researchers felt that these teachers had been teaching science for years and were not interested in changing their delivery style.

At the end of the experimental year, all the participants in the study completed a survey indicating how often they used the kits and why they did so. One positive result reported by Blanchard et al. (2011) was:

Higher frequency kit users were more likely than low kit users to report having students engaged in inquiry-related instruction that required students to explain concepts just as the lower frequency kit users were more likely to have students engaged in traditional forms of instruction. (p. 2389)

Blanchard et al. (2011) go on to say that the teachers who used the science kits frequently would use different types of assessments as compared with the teachers using traditional teaching styles. Some of these assessments included portfolios, projects and small group discussions and questioning. These researchers also pointed out that many of the new teachers were exposed to kit use and inquiry-based science in their undergraduate studies but still preferred to use traditional delivery styles in their science classrooms. They felt that the reason behind this finding was that with a traditional

delivery style, a teacher can limit questions and discussions and in that way, their lack of the core science knowledge will not be exposed.

Blanchard et al. (2011) also pointed out that the feelings of some of the teachers on why they did not use the kits frequently was because of some district's pressure on the teachers to raise their standardized test scores. Therefore, this study is important because it reflects the feeling of a large group of teachers who were already under pressure to raise their test scores and therefore get off of the list of schools who did not make adequate yearly progress the preceding year. So these teachers felt that with these pressures on them, they did not want to spend that extra time on something they were not sure of, rather than using the traditional delivery system with which they felt comfortable.

Many studies had shown the importance of inquiry based science education and how it can be so beneficial for student learning. Therefore, possibly making the use of these science kits more user friendly, by providing more professional development and district support could actually lead to more learning on the students' part and therefore higher test scores which are of a top priority in education today.

Prior to Blanchard et al.'s (2011) study, Dickerson, Clark, Dawkins, and Horne (2006) conducted a study in which 2,299 3rd, 4th and 5th graders in 10 different schools were evaluated in their science knowledge based upon the different curricula and instructional methods used in their science education. Basically the study was conducted to compare the use of science kits to more traditional methods of instruction. Five schools that used the science kits over a two year period were compared to five schools that used traditional methods of teaching science. The schools were chosen based on similar demographics, namely, state test scores, percentage of students using the National

School Lunch Program and percentage of non-white students. Each kit using school was matched with a school not using the kits but with similar demographics. With the exception of one, while comparing the controlled and treatment schools, there was no statistical difference between the two groups or there were statistical differences favoring the treatment schools. These researchers felt that with a systematic implementation of science kits, student understanding of science concepts were enhanced. In discussing the variables in their study, Dickerson et al. stated:

We acknowledge many variables exist as frequency of kit use, implementation of kits, alternative approaches implemented in comparison schools, and teacher and student affective variables, all of which may serve to provide further insight into the effectiveness of the use of science kits in the classroom. (p. 48)

Dickerson et al. (2006) concluded their study by stating that they feel it is logical to state that the students using the kits in an active learning environment would develop a more favorable attitude toward science as compared to the students in the control groups learning in a more passive learning environment. They go on to say, “Logically, if content knowledge test scores yielded by a passive and an active approach are about the same, the attitude advantage makes the active science education approach a better choice” (p. 48).

Besides the increase in students’ attitudes toward science, Dickerson et al. (2006) felt that their study also revealed similar attitude changes with the teachers using the kits. Rubino, Barley, and Jenness (1994) addressed this issue in a survey study of 397 teachers using science kits in conjunction with professional development workshops. They stated that close to 70% of the teachers reported an increase in their science knowledge through

the workshops and using the kits in their classrooms. Also, 96% of the teachers reported an enhanced attitude toward science as a result of the workshops and use of the kits.

Along these lines, Dickerson et al. (2006) stated:

If teachers exhibit greater confidence in their science teaching by using kits, it is logical to conclude that a systemic implementations of kits in a school district would make a difference for teachers who dislike science and/or who lack confidence in teaching science. If teachers replace teacher-centered instructional strategies (e.g., textbook readings) with activities that actively engage children, there should be improvement in both student understanding of science and their attitudes toward science. Despite the challenges (e.g., logistics, teacher resistance) of implementing systemic science kit use within school systems, the properties of enhanced content knowledge and improved attitudes towards science make them a viable option for effective science teaching and learning. (p. 49)

Some school have tried to use “Do-It-Yourself” science kits with limited success, primarily because they lacked the professional development component associated with their kits.

Rennie, Howitt, Evans, and Mayne (2010) discussed present day use of science kits in elementary schools. They report that many school districts are implementing science kits and providing the professional development for the teachers to become familiar with the kit’s materials and how to use them most effectively in their respective classrooms. They mention positive results of kit usage as; increased teacher core science knowledge, increased teacher confidence and increased enthusiasm for science demonstrated by the students. They go on to say that DIY (Do-it- Yourself) kits can

provide similar results but when used without the proper professional developments, they met with limited success except when used by seasoned confident teachers. These authors conducted a study where four Australian schools used a DIY science kit on Astronomy which was developed by the researchers. These teachers did not receive any initial professional development prior to using the kits.

Rennie et al. (2010) reported that the use of this astronomy kit was met with limited success. Some of the complaints were that the over abundance of supplies made it difficult to use all the materials. They also said that student handouts were insufficient in quality and were not very useful. Lastly, they mentioned that the lack of professional development prior to using the kits was a major drawback in this study. Their final conclusions from their study revolved around two things, namely, “kits must be carefully targeted at their users” (p. 16) and “the effectiveness of kits depends on teachers’ knowledge” (p. 16). To address the first conclusion, these researchers suggested that; the kits should be better organized, have fewer supplies and match the length of the unit in which it is being used. Along these lines, they also felt that; the kits should be focused to a certain grade level, have photos of the experiment setups and the expensive components should be more available to the teachers. With the second conclusion involving the teacher’s knowledge, they suggested that the teachers need time to familiarize themselves before using them, the materials used need to be more flexible to match the teacher’s core science knowledge, the activities have a direct connection to the science concepts being studied and that required professional development be implemented. These researchers finished with the comment that the students definitely enjoyed using the kits in this study

but more work needs to be done to match the kits to the needs of the teacher and their lessons.

Student attitudes about science and their classroom environment was addressed by Houston, Frasere and Ledbetter (2008). They conducted a study on 588 3rd and 4th graders and collected data on the effectiveness of instruction using the typical science textbook, science kits and a combination of both. They addressed basically three questions, namely; can the classroom environment be assessed, can the use of a textbook or science kit or a combination of both change students' learning and attitudes about science and, is there a connection between the students' attitudes about science and the learning environment? The students were broken up into three groups in order to do the evaluations about using the textbook, using the science kits and using the combination of both. Qualitative and quantitative methods were used to collect data over a one-year period by use of surveys and questionnaires. The results showed that the classes using the science kits liked learning science the best while doing all of the exciting activities and had the best learning environment due to better cohesiveness and less friction in the classroom. Teachers also enjoyed teaching with the science kits but did complain from time to time about the time involved in setting up some of the experiments.

In conclusion of this section, I found that many of these studies compared teaching methods using science kits versus the typical textbook, lecture style of teaching. The findings of these studies showed that when the students had the chance to do inquiry-based science by use of science kits, students' interest increased resulting in better, more successful science learning. They also pointed out that when teachers learned how to use

inquiry-based instruction with the science kits properly, they also enjoyed the teaching experience with their students.

Professional Development on Kit Usage

In this section, I researched the importance of teacher professional development on inquiry-based learning and how to use it when teaching science with science kits. The importance of connecting professional development with kit usage has been an important concept to consider in successful science kit usage. Earlier attempts have been made back in the 1960's to use science kits but met with limited success because professional development was absent.

Jones and Eick (2007) conducted a study to evaluate the implementation of science kit in a rural school located in the southeastern part of the United States. The study involved six middle school science teachers who volunteered to attempt integration of science kits into their classrooms over a two - year period. They talked about how science reform, by use of classroom science kits, was attempted back in the 1960's. They went on to say that the 1960's reform methods failed because they used top-down models which had the teacher at the bottom. The new ideas about science kits are just the opposite today where a bottom to top model is used and the teacher is the center of focus. They say, "If teachers are considered an active part of change, then they should be heard in order to make inquiry reform more obtainable and sustainable for all teachers' contexts" (p. 493).

As previously mentioned in Chapter I, Jones and Eick (2007) described the kits used in this study as:

The curriculum packaged as a kit included lesson plans, hands-on materials,

background information, supplemental readings, and performance assessments. The kits' lesson plans provided a structure based on preset curricular topics that constructively allow students to work through a series of hands-on activities following a learning-cycle model and work up to inquiry-based activities in which students are gathering and analyzing data. (p. 494)

Jones and Eick (2007) conducted structured interviews of the six teachers at the beginning of the study, during the second year and at the end of the project. They also conducted six classroom observations for each teacher over the two-year period. Their findings reported in this study revealed several things that should be taken into account when adopting a science kit program. Lack of a good science background was less of a problem when using the kit programs because professional developments involving the kits provided the knowledge need to use the kits. This was considered top-down support and extremely important in implementing the kit curriculum. Time was listed as a limitation to using the science kits. Setting up experiments and giving the students enough time to complete them took more time than initially contemplated. Having the students use journals throughout their investigations was considered a big positive for use of the kits. All the teachers understood the importance of inquiry based science teaching but they struggled with kit implementation initially until their professional development lesson kicked into gear. There was a lack of sufficient professional developments prior to these teachers making an attempt to implement the kit curriculum.

Jones and Eick (2007) complete their study by saying,

There teachers' experience in kit implementation was initially hampered by their self-imposed lack of further kit training prior to use, but the top-down support that

they received was complimented by the bottom-up perspective of this study. This dual perspective showed how professionals could cope and adapt. These bottom-up cases of adaptation are worth studying in order to make professional development more insightful and account for the development of practical knowledge and general learning in order to support well-intentioned teachers. (p. 51)

For years, teacher professional development has been required throughout the school year across the country. Some are focused and others cover a variety of subject throughout the year. When a school district adopts a certain curriculum, in this case, science kits, extensive professional development is required prior to and during the implementation phase of the adoption.

Young and Lee (2005) conducted a study to show the importance of professional development in schools adopting science kits for their elementary school teachers to use in their classrooms. Since many elementary teachers are not well versed in science content or the skills of teaching elementary school science, professional development is especially important for them. “This investigation gathers evidence to reveal the relationship between the independent variables, (i.e., level of kit use in the science curriculum and amount of teacher training) and two dependent variables (i.e., pretest and posttest science achievement scores)” (p. 473).

The two test groups consisted of approximately 100 students each. One set of students had science teachers who received a large quantity of professional development and the second one was a group of students who had science teachers with very little professional development. All of the students in the study were tested before the study

began and again at the conclusion of the study. Teacher questionnaires were used in the study as well. “Teacher questionnaires were administered each time to collect information about preparedness, experience, and practices that could be associated with student science achievement” (p. 473).

Young and Lee (2005) discussed their results in two areas. The first one dealt with the classrooms that did not have any kit use and were not part of this study except for the comparison on posttest scores. The classes without kit use had significantly lower scores on the posttest as compared to the one that did use the kits. The study also found that the teachers who did not use the kits taught longer lengths of time as compared to the teachers using the kits. It was felt that in this case, the expression, less is more, might be appropriate. The second one dealt with the amount of professional development the teachers in this study had. The results show higher scores for the students who had teachers with more professional development time but not to a significant level. They feel that this result might be from the students having a mixture of teachers before the study who had high and low levels of professional developments.

Young and Lee (2005) go on to address the real issue of which districts can adopt the kit programs and which ones would have financial problems in do so. It basically comes down to money since these kits can be quite expensive. So before the money is spent, districts need to commit to all the aspects of the kit usage, especially the support provided by the district and the much important professional development component. They say,

In the financial challenges that districts are facing coupled with the national emphasis on reading and mathematics, the ability to examine the value of kit-

based science combined with ongoing training support for teachers is essential to implementing and continuing science curricular reform at the elementary level. (p. 480)

Research on comparing professional development on science kits and teacher self confidence is important because it addresses the fundamental reasons for using the science kits, namely, to help elementary school teachers feel more comfortable with teaching science, therefore resulting in increased student achievement.

Sherman and MacDonald (2008) conducted a study of over 40 elementary school teachers about their use of science kits in their classrooms. These teachers have been interviewed and completed a survey about their experience of using the kits. The importance of professional development on the kits and their usage was essential to the successful implementation of the kits in their classrooms. The participants reported positively on such things as an increase in the teacher's core science knowledge, teacher confidence and student excitement about science. The excitement lead to the students asking when they can do the next activity and spreading of the newly acquired knowledge into other curricular areas. Once the teachers have acquired this new confidence in teaching science, they are seen modifying the kits to their daily needs and adding new activities.

Sherman and MacDonald (2008) concluded their study of the 40 participants really reflected the importance of the professional development in their program. They said,

The evidence provided by these teachers suggests there is a need for substantially

increasing this type of science PD for elementary teachers. The kits have increased the propensity of teachers to think about classroom-based science teaching and learning events over an extended period of time. This kind of interaction has the potential to generate teaching resources that support the development of enhanced pedagogical content knowledge through continuous professional development. (p. 97)

Blanchard, Southerland, and Granger (2008) stressed the importance of professional development on the inquiry-based instruction used with the science kits. He pointed out that the NRC (2000) stated, “For students to understand inquiry and learn to use it in science, their teachers need to be well versed in inquiry and inquiry-based methods” (p. 87), and professional development meetings is where this is studied, evaluated, and supported among the teachers using it. Weiss, Montgomeery, Ridgeway, and Bond (1998) stated that, “The literature on effective staff development emphasizes the importance of establishing a professional development culture where teachers can explore content and pedagogy in a collegial, risk-free environment” (p. 6).

The researchers I studied in this section all emphasized the importance of teacher professional development on a routine basis. They stressed that the elementary school teachers using science kits in their classroom need to structure their professional development around the successes and difficulties each of the teachers are experiencing. Also, they stressed the importance of having examples of good inquiry-based science kit lessons provided to or demonstrated by the participating teachers. As stated earlier in the self-efficacy section, the support and collegiality of other teacher is extremely important in promoting confident elementary school science teachers.

Science Kit Formative and Summative Assessments

In this section, I researched authors who stressed the importance of using formative and summative assessment in evaluating student learning during various times throughout the science lessons. They also discussed the use of assessments to reflect accountability for teachers and schools.

Gitomer and Duschl (1998) discussed the nature of assessment use in evaluating students in a science classroom. They said that in the review of the principles of assessment, that there is a relationship between the educational task structure and the social values that are incorporated into the assessment and the type of results desired from the assessment. They go on to say that a major source of influence on assessment comes from research obtained from cognitive and educational psychologists. Along these lines, Gitomer and Duschl stated:

The research in cognitive psychology and educational research suggests that science learning requires the development of cognitive and metacognitive skills across several integrated knowledge domains (i.e., notational conventions, epistemic rules and conceptual understandings). (p. 806)

Gitomer and Duschl (1998) voiced that all three of the domains need to be addressed during the instructional portion of the lesson and found in the subsequent assessments. They also feel that these three domains should be combined into the teaching and assessment efforts and not be compartmentalized into discrete domains as many teachers use today. With this combined effort, they feel that the assessments will provide better information to the teachers, students and parents.

Gitomer and Duschl (1998) go on to say that today many teachers look for other means to assess their students. They stated that

The called-for enhancement of feedback through the use of performance and portfolio assessments is a complex problem that requires systematic research efforts. In particular, research needs to be done at the level of the classroom to understand and shape the consequential validity of teachers' assessments and inferences drawn to alter curriculum and instruction. (p. 807)

Each "Unit Science Kit" contains several formative assessments and one summative assessment for the respective units. Two researchers, Black and Wiliam (1998) have written several articles over the past twenty years in an attempt to give a better understanding of what formative and summative assessments are, how to use them and why they are so important.

Black and Wiliam (1998) provided a general definition for assessments to include all the ways a teacher can get information from their students to show that they are understanding the material. Their definition does not only include exams, but also includes homework, observations and classroom discussions. They stated that, "assessments become formative when the information is used to adapt teaching and learning to meet student needs" (p. 2). They go on to say that if formative assessments are used properly, they will not necessarily only focus on the correct answer, but gives feedback to the student in a way that shows them where they went wrong and how to take action to remedy their misunderstanding. This leads to the comments of Fontana and Fernandes (1994) about student involvement in their learning. They stated,

While feedback generally originates from a teacher, learners can also play an

important role in formative assessment through self-evaluation. This experimental research study has shown that students who understand the learning objectives and assessment criteria and have opportunities to reflect on their work show greater improvement than those who do not. (p. 408)

Black and Wiliam (1998) go on to express their thoughts about pre-service teachers learning the importance of classroom assessment and how to use it, and the importance to continuing professional development in helping the new teachers have the time and support to evaluate their assessment methods and make changes if necessary.

Today, there is a concern that maybe our students are tested too much or taught and tested in a way so they can be successful on local or state assessments. Some educators call this “teaching to the test.” Bell and Cowie (2001) addressed this by stating that this is not only a U.S. concern, but, an international one as well. They refer to this problem as “accountability assessments.” They say that there still remains the teacher needed assessment which provides the teacher with the knowledge of how their students are learning and also provides needed feedback to the student which is so essential to their learning. But along with this, they point out that assessments are also used for accountability purposes. They point out a statement made by the (National Research Council, 1999) which says,

A third purpose of assessment is to drive changes in practice and policy by holding people accountable for achieving the desired reforms. This purpose, called “accountability assessment”, is very much in the forefront as states and school districts design systems that attach strong incentives and sanctions to performance on state and local assessments. (pp. 1-2)

While discussing formative assessments Bell and Cowie (2001) go on to address the importance of summative assessments. They say that parents, along with educators and policy makers need to understand what the students are learning in comparison to peers in other similar schools. “This purpose often called ‘summative assessment’ is becoming more significant as states and school districts invest more resources in educational reform” (p. 538).

Shepard (2000) addressed the need for gradual change in classroom assessments and suggested that the best way to achieve these changes is through teacher professional development. She states, “Being able to ask the right questions at the right time, anticipate conceptual pitfalls, and have at the ready a repertoire of tasks that will help students take the next steps requires deep knowledge of subject matter” (p. 71). She encourages teachers to spend professional development time working on these abilities. She continues this by saying that many of the new ideas might meet with some resistance and therefore, the teachers will need support from their peers in order to understand their beliefs and how they relate to those of students, parents, colleagues and administrators.

Bangert-Downs, Kulik, and Morgan (1991) pointed out the real importance of assessments depends upon the quality and saliency of what the teacher collects. They go on to say that students need feedback on the assessments in order for them to not only get the correct answers, but to demonstrate a change in their behaviors about what they are studying. This feedback can be done in various ways ranging from having the students receive the correct answers to an elaborate feedback method requiring further study of the material and trying to approach it in different ways for better understanding.

Two decades ago, the National Science Education Standards (1996) addressed student assessment. It points out that classroom student assessments extend way beyond the classroom. This document states that,

assessment is a primary feedback mechanism in the science education system.

For example, assessment data provides students with feedback on how well they are meeting the expectations of their teachers and parents, teachers with feedback on how well their students are learning, districts with feedback on the effectiveness of their teachers and programs, and policy makers with feedback on how well policies are working. Feedback leads to changes in the science education system by stimulating changes in policy, guiding teacher professional development, and encouraging students to improve their understanding of science.

(p. 76)

These National Science Education Standards (1996) go on to point out that student assessment is not only done with pencil and paper test but consist of many other things such as observations, discussions, student presentations and portfolios to mention a few. Another important shift in assessment at that time consisted of what was referred to as “authentic assessment.” It states that,

This movement calls for exercises that closely approximate the intended outcomes of science education. Authentic assessment exercises require students to apply scientific knowledge and reasoning to situations similar to those they will encounter in the work outside the classroom, as well as to situations that approximate how scientists do the work. (p. 78)

Roughly two decades later, the Next Generation Science Standards appeared on the scene with a different opinion about student assessments. Herman (2013) discussed the changes in assessment that have taken place over the past twenty years. He states that in the past, too much attention was paid to “accountability testing of learning.” This type of assessment was used to show student progress in order to achieve new performance goals, new school programs and incentives or sanctions to motivate action. He said,

Today, however, there is growing recognition of the limitations of accountability testing of learning and wide acknowledgment and accumulating evidence of the crucial role that formative assessment – assessment for learning – can play in helping all students achieve rigorous standards. (p. 2)

Herman (2013) goes on to say that in this new model of assessment, teachers want to look forward rather than back to see what the students have learned. This new model wants teachers to continue assessing throughout class to determine where their students are and immediately make necessary corrections for better student understandings. He stated his feeling about the importance of formative assessment by stating, “Formative assessment must also be an essential – if not the key- component of any assessment system for the Next Generation Science Standards” (p. 2).

Herman (2013) explains the ever-going classroom assessments in progress by stating,

From a teacher-centric perspective, teachers start by making their learning goals clear and knowing how that learning is expected to develop. Teachers collect evidence of where students are relative to that progression by asking students questions, observing student activity, and analyzing student work. Teachers’

analysis of student responses enables them to interpret the status of student learning and to identify the gap between where students are and where they need to be. Teachers then use these interpretations to provide feedback to students and take instructional action to help students clarify their misconceptions and bridge identified gaps...and the process starts all over again. (p. 5)

The issue of summative assessments in elementary school science classrooms has met with some discourse. Some authors believe that elementary school formative and summative assessments should be balanced in use. They feel that even though they are different in nature, their proper use will help teachers better understand their students' learning in the classroom and in their preparation for standardized exams. Garrison and Ehrlinghaus (2011) defined formative assessment in a very similar way that other authors previously mentioned do, whereby summative assessments are exams that are given at certain times in the year to see what the students know at that particular time. They say that many people associate summative assessments with standardized exams that are required by the local or state departments of education. They also say that summative assessments are used for teacher and school accountability as well as for grades at the end of some school period. Garrison and Ehrlinghaus go on to point out since summative assessment can be strung out to cover materials over a week, month or years, it cannot be used as formative assessments are used because formative assessments can actually be daily assessment by the classroom teacher. But, summative assessments can be used to evaluate the effectiveness of a program, levels of school goal achievement and possible placement of students in certain programs. They conclude their summary of assessments

by stating that both types of assessments are important and have their own place in student learning.

The formative assessments and summative assessment found in each unit kit for the schools in my study have been routinely updated throughout the years. The developers of the Next Generation Science Standards are now in the process of writing assessments geared to these new standards and will be used in the “Unit Science Kit Program” when they are available.

In this section, I found that these researchers feel how important it is for teachers to use formative assessments and summative assessments correctly. They stated that it is an excellent idea for teachers to routinely use formative assessments during their lessons so, both the teacher and student, can see where they are in the learning process for this material. The teacher’s role in collecting data and giving the students timely feedback is said to be very important in the learning process. Lastly, they discussed the need for summative assessments in preparing students for various state required assessments and for teacher and school accountability to the parents and tax payers.

Reading and Writing in Science

The authors I researched and summarized in this section addressed the importance of reading and writing in science. As part of inquiry-based instruction in science, reading and writing and a student’s ability to express their thoughts and questions about the subject matter, is discussed by these researchers.

Glynn and Muth (1994) discussed the importance of teachers having a scientific literacy curriculum in order for students to learn meaningful science. They say, “In a scientific literacy curriculum, reading and writing can serve as dynamic vehicles for

learning science meaningfully” (p. 1057). The American Association for the Advancement of Science (AAAS) (1989) defines scientific literacy as:

... one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; and use scientific knowledge and scientific ways of thinking for individual and social purposes. (p. 4)

Glynn and Muth (1994) stated that by using this definition of scientific literacy, most students cannot be considered scientifically literate and many of these students are female and minorities. Even though this might be the fact, efforts continue to rectify this deficiency in elementary school education. They stated that teaching students more scientific information and doing more hand-on activities will not, by themselves, increase scientific literacy. That go on to say, “What is additionally needed is a ‘minds-on’ emphasis in the learning of science” (p. 1058). By saying “mind-on,” these authors mean that the students need to be able to understand scientific concepts and explain them in both, reading and writing.

In 1989, The American Association for the Advancement of Science (AAAS) identified science process skills as: “(a) computational, (b) estimation, (c) manipulation, (d) observation, (e) communication, and (f) critical response” (p. 1061). Glynn and Muth (1994) believed that the last two, communication and critical response, are the two most important skills need for a student to have and the ones that can be obtained by use of reading and writing in science. For student reading, these authors recommended such

things as newspapers, trade books, reference textbooks and scientific biographies to name a few. Concerning this, Glynn and Muth stated that,

In a teacher-driven curriculum, a textbook may still play an important role, but as a reference rather than a curriculum guide. The teacher is empowered and has much more control over the instructional methods and the use of other print-based materials, such as trade books, magazines, and biographies of scientists. The teacher-driven curriculum assumes that the teacher knows a great deal about science, about methods of instruction, and about the basic skills of reading and writing. (p. 1062)

Rice (2002) discussed the use of trade books in elementary school science classrooms. She stated that the use of trade books in science classrooms is a good idea but teachers need to select them carefully. They state that teachers need to evaluate the trade manuals before the students read them because many have errors or present misconceptions to the students. They suggest that student reading should not be limited to trade books but they should be used in conjunction with other reading materials. She goes on to say that many teachers today feel that with hands-on science instruction, there is not time for reading. She stated, "...there are in fact, a number of strategies for teaching science that combine the strengths of reading and activity-based science instruction" (p. 561).

Concerning writing in science, Glynn and Muth (1994) said that with this activity, students can reflect back on their previous science knowledge and science process skills which can then show them how science is involved in many real-world situations. This also shows them that science is a living entity and not just rote knowledge they learn in

school. They recommend various writing activities as using essays, field trip notes, laboratory logs and scientific journals as just a few suggestions for the teachers.

Glynn and Muth (1994) concluded their report by stating that reading and writing should be integrated in many of the students' science activities. They stated that, "Integrated reading and writing activities can play a vital role in achieving a "mind-on" emphasis in the learning of science" (p. 1069).

I found in this section how important it is for students, specifically science students in this study, to have the ability to locate and understand literature concerning the topics they are studying and then be able to express their thoughts through writing or other methods of communication.

Teacher Demographics

Teaching Experience

The researchers in this section discuss the importance of teaching experience and science background knowledge in making successful elementary school science teachers.

Researchers have discussed how much teaching experience is reflected in their respective students' learning. Some feel that the best teachers are the ones with the most experience, but research has revealed that after several years of teaching, experience does not really play a role to any great extent. Darling-Hammond (2000) conducted a study by evaluating surveys from 50 states that looked at teacher qualifications and other school demographics and how they influenced student learning. One of the categories of the study evaluated years of teaching experience and how it is reflected in student learning. Her study explained that for the first three years of teaching, experience is important, but around the five-year mark, experience had little affect on student learning outcomes. She

attributes this to the fact that many new teachers are more energetic and interested in doing a good job teaching as compared to more experienced teacher who may have not continued working on their teaching skills and have leveled off in their interest and energy levels. She also stated that students who attended a five-year teaching undergraduate program, which included a one-year of student teaching and a masters program in education were more confident and capable than students who went through a typical four-year undergraduate program. She also stated that the teachers who participated in the extensive pre-service program were equally capable as more experienced teachers.

Along these lines, Rice (2010) discussed her research findings about teacher experience and effective teaching. Her results are similar to the ones of Darling-Hammond (2000). She stated that, “The impact of experience is strongest during the first few years of teaching; after that, marginal returns diminish” (p. 1).

Major/Minor in Science

Darling-Hammond (2000) continued her report stating that a teacher’s general academic abilities and intelligence had only a small insignificant affect on student learning outcomes.

Darling-Hammond (2000) also commented on a teacher’s background knowledge and how it affects student learning by mentioning the work of Byrne (1983). Byrne stated that research on how knowledge of a particular subject, as measured by a standardized exam or by the number of college courses taken, plays a role in a student’s learning is equivocal. He goes to explain one possible explanation of this result, by

noting that a teacher's knowledge in a subject area is important up to a point of basic competence, but has little effect after that.

Byrne (1983) finished his comments by discussing how a teacher's knowledge of teaching and learning plays a role in student learning. He stated,

It is surely plausible to suggest that insofar as a teacher's knowledge provides the basis for his or her effectiveness, the most relevant knowledge will be that which concerns the particular topic being taught and the relevant pedagogical strategies for teaching it to the particular types of pupils to whom it will be taught. If the teacher is to teach fractions, then it is knowledge of fractions and perhaps of closely associated topics which is of major importance.... Similarly, knowledge of teaching strategies relevant to teaching fractions will be important. (p. 14)

Goldhaber and Brewer (1996) wrote a paper to identify what school qualities contribute the most to student learning. The qualities extended from the amount of money the state spends per pupil, to school governance, to teacher qualifications and experience, and to the family and economic status of each student. When looking at a school's student achievement evidenced by standardized test scores, Goldhaber and Brewer (1996) introduced studies done by Hanushek (1986). They reported what Hanushek stated while evaluating previous studies in which the results showed that the work concluded that individual and family background traits explain the vast majority of variation in student test scores. The effects of educational inputs such as per pupil spending, teacher experience, and teacher degree level have been shown to be relatively unimportant predictors of outcomes, and the impact of any particular input to be inconsistent across studies. (p. 1162)

Strauss and Sawyer (1986) conducted a statistical analysis comparing a teacher's quality as reflected on their students' standardized test scores and the students' rate of exam failure. When these researchers discussed their findings, they said, "...our most startling finding is that a 1% increase in teacher quality, ... as measured by standardized test scores, is accompanied by a 5% decline in the level of failure or rate of failure of students on high school competency examinations" (p. 41).

Strauss and Sawyer (1986) pointed out that a teacher's quality has a much greater affect on students in the classroom who are at risk than do class size or other administrative decisions. Lastly, they stated that the teacher's quality has a much greater affect on student failure rates as compared to student average performance in the classroom.

Years Using the Kits

I researched the literature on "the number of years teaching with the science kits" and was unable to locate any studies related to this topic.

I found in this section that teaching experience is important to a point. Darling-Hammond (2000) and Rice (2010) stated that after 5 years of teaching experience, having more teaching experience essentially does not produce more successful student learning. They also stated that pre-service students who have had an extensive pre-service teaching program, along with post college learning, are equally able to successfully teach in their first year at the same level as teachers with a considerable amount of teaching experience.

As far as a major or minor in science, Darling-Hammond (2000) stated that having this is not really that important for elementary school teachers to teach science successfully, as long as they have a basic understanding of and an appreciation for

science.

Teacher Gender

Lastly, does gender possibly play a role in teachers' feelings about teaching science? This section discusses the history and importance of gender differences in teaching elementary school science. With going back in history, one can see how gender had an influence on this matter.

For many years, the great majority of elementary school teachers were female. As time has passed, more men have become elementary school teachers, but they are still in the minority. Regardless of which gender the elementary school teacher is, teaching science at the elementary level has always become somewhat burdensome for many reasons, including pre-service training, science core content and basic self-efficacy.

Todd (1958) stated that:

The vast majority of the studies in this field point to the discouraging fact that most elementary-school teachers have had little or not training in science; the training they do possess is of little value in their work with elementary-school children; and as a result of their lack of training, they "shy away" from teaching science. (p. 385)

It was not until the 1980's that the United States made a serious effort to reform elementary school science programs. Along those lines, it is interesting to see what Todd (1958) has written about these problems as far back as 1958. In her article, she discusses how the accepted role of a female at that time permeated throughout education at every level. She points out that most scientist were men while women had their duties which were more feminine in nature. She does point out, as other authors have, that children get

their initial feelings about science based upon how they perceive their parents' and teachers' attitudes about it. Todd continues with examples of various situations involving a teacher-student interactions on common everyday things. She talks about a little boy who found a shiny rock outside of the school and brought it in to her to see if it was gold. She addresses several ways some teachers might handle this situation. The reactions ranged from, take that rock out of here because you are getting dirt on everything, to let's see if you and I can figure out if that stone is gold or just pyrite. She concludes her study by saying:

Recognizing her social inheritance, the woman teacher is in a position to do something about modifying her legacy with attitudes more appropriate to science-teaching. Through workshops and other educative experiences, she can study science and acquire attitudes that lead her to encourage her pupils, and often to share with them, first hand science activities. As more and more elementary-school teachers revise their attitudes, pupils' interest in science will remain strong throughout the elementary grades and girls and boys, as well as their teacher, will learn more science.

In this section Todd (1958) explained that for years throughout the past, most elementary school teachers were female while the men were found more commonly in industrial and engineering positions. Women felt that this was their role while men were being educated as scientist and engineers. Therefore, female pre-service teachers were shy about taking college science classes.

School Demographics

The specific school demographic of interest in my study is the percentage of students using the National School Lunch Program and how that affects their scaled 5th grade state science exam scores.

The authors summarized in this section investigated the socio-economic factor of students and how this factor plays a role in student learning and achievement. They also discussed the present “Free and Reduced Lunch Program” which is now designated as the “National School Lunch Program.”

Since the mid-seventies, programs have been instituted to provide school lunches to needy students. The research done on these programs dealt with using a student’s Socio-Economic-Status (SES) to determine his or her eligibility for the free or reduced lunch program. Today, this program is known as The National School Lunch Program. Santrock (2004) defines SES as “the grouping of people with similar occupational, educational, and economic characteristics” (p. 583). When researchers look at a school’s SES and achievement, they use the school’s percentage of students eligible for the National School Lunch Program and essentially use these terms synonymously.

Walpole (2003) added to Santrock’s definition of SES by pointing out that, “low” SES students also tend to have less access to cultural capital (specialized or insider knowledge not taught in schools) and social capital (contacts in networks that can lead to personal or professional gains), which have ben argued to be key components of a student’s educational success. (p. 46)

Harwell and LeBeau (2010) stated, “We argue that education researchers who use the FRL (Free and Reduced Lunch) variable as a measure of SES typically do so because this information is easily accessible and relatively inexpensive” (p. 121). FRL is now known as NSLP (National School Lunch Program).

Leventhal and Brooks-Gunn (2000) conducted a review of research on what role a neighborhood or SES plays on many factors including educational success. Their research investigated children in respect to school readiness and achievement and their respective neighborhoods. Their results showed that, “during early childhood and adolescence, the most consistent finding was that high-SES neighbors had a positive effect on school readiness and achievement outcomes” (p. 315). They go on to say that high SES distinction is based on several percentage factors such as: moderate to good yearly incomes, managerial/professional workers and college educated individuals. And, these results reflected positively upon their children’s IQ, verbal skills and reading recognition scores, and followed later by a higher percentage of students graduating from high school and subsequently, attending college.

Brogan (2009) goes on to explain a number of advantages and disadvantages found with high SES families and low SES families respectively and some of the causes for both. If you can picture what poor neighborhoods look like as compared to middle class or higher class neighborhoods, you can understand what Brogan is talking about. For low SES families, he points out the fact that there are more problems with child development because of more cases of lead poisoning, fetal alcohol syndrome and premature births leading to poorer school outcomes because of delays in language development, learning disabilities and attention deficit disorders. He goes on to compare

the parenting styles in these two SES categories. He shares that parents of high SES families are more conversational with their children and less directive as found in low SES families. He continues his comparison by saying,

Low SES parents are more likely than the high SES parents to expect obedience without question from their children. Low SES parent expect their children to conform to society's expectations, while the high SES parent encourage creativity and exploration. These differences foster self-confidence in the high SES students and an uncertainty about life in the low SES students. (p. 1)

Lastly, Brogan (2009) discussed the difference in low SES and high SES neighborhoods as far as violence, depression, low self-esteem and juvenile delinquency. He concludes his article by discussing the relationship between school outcomes and school SES. The first thing he mentioned was that, in general, low SES districts have fewer resources and have less experienced teachers because they receive lower pay and work under more difficult conditions. Therefore, these districts have lower academic achievement, fewer high school graduates and fewer students going to college. The second thing he mentioned was that students in these low SES schools develop the self-fulfilling prophecy of failure. This means that these students are surrounded by individuals who did poorly in school, ones that might have been overlooked by the teachers because they were quiet and therefore not considered to be very bright. These students are left with a feeling of failure and therefore, low self-esteem which leads them to look for ways to confirm this self-concept. The third thing he addressed was student tracking in mixed SES schools. Depending how you did the previous year, you are put into easier classes or directed into a college bound track. The fourth thing he mentioned

was student home support. Brogan noted that the educational level of a family depends upon the level of education the mother has attained. It is expected that in most high SES homes, the mother has at least a bachelors degree. He goes on to say that this lack of support by the family can be changed by a parent making the kids focus more on school work and activities and less on television and video games. Lastly, Brogan suggested that parents with students attending schools in low SES districts need to initially have their children enrolled in a Head Start program and summer educational programs as well.

I learned in this section that a student's socio-economic-status, along with all of its ramifications, can be a possible predictor of their school achievement. A cause and effect relationship cannot be established between these two variables, but the former can be used as a predictor of the latter. To determine a school's socio-economic- status, today's researchers use the school's percentage of students on the National School Lunch Program as the indicator.

Chapter II Summary

Chapter II contained a review of the literature associated with this research project. The purpose of this project is to collect the perceptions of elementary school teachers who are teaching science using the "Science Unit Kit Program," and examine any connection to student science scores. The perceptions captured will focus on a number of factors ranging from teacher pre-service program preparations to the learning and adoption of inquiry-based science instruction by use of a kit program.

Previous research has revealed that the importance of a teacher's understanding of the "Nature of Science" is directly connected to a teacher's confidence, or self-efficacy,

in his or her abilities to teach various subjects; in this case, science. Previous researchers emphasized that fact that a teacher's understanding of the "Nature of Science" is sadly often overlooked in their pre-service training. These factors are also directly related to a teacher's performance in the classroom and student learning.

This chapter included an explanation of what is considered a good pre-service training program including the need for a strong science background and strong inquiry-based methods classes. Roadblocks to good elementary school science teaching were also discussed.

The use of inquiry-based instruction by use of the science kits was also covered, as were the various components of the kits including their experiments, assessments, professional developments on the kits and reading and writing in science.

Various teacher demographics such as gender, years of teaching, years of using the science kits and having a major/minor in science were also discussed as to their respective connections in teaching elementary school science. Lastly, the importance of a school's demographics as reflected by the percentage of students using the National School Lunch Program was discussed. Examples of possible connections between these percentages and the affects they may have on achievement were presented.

Next is Chapter III in which a detailed methodology of my study is presented.

CHAPTER III

METHODOLOGY

This chapter explains the methods used to collect and analyze data using a researcher-developed Internet-based survey addressing elementary teachers' perceptions regarding usage and other issues related to science kits in their classrooms.

The specific sections covered in this chapter are: overview of purpose and methods; research design; population, sample and site; instrumentation; data collection procedures; data analysis; cross walk table; and limitations and delimitations.

Overview of Purpose and Research Questions

Since the middle of the 20th century, many research studies and programs have been implemented in order to address the problems associated with teaching science in elementary school (Mazur, 2009). As stated in Chapter I, the U.S. Department of Education (2004) encouraged researchers to continue their attempts at improving elementary school science programs by stating, "Over the last decade, researchers have scientifically proven the best ways to teach reading. We must do the same in science. America's teachers must use only research-based teaching methods and the schools must reject unproven fads" (p. 1).

As stated in Chapter I, the purpose of this study is to add to the research in the area of elementary school science as recommended by the U.S. Department of Education (2004). Specifically, the purpose of my study is to collect the perceptions of teachers in a large number of elementary schools in which the teachers have been using a "Science Unit Kit Program" over the years. Perceptions will focus on: (1) actual kit usage over time; (2) levels of training and self-efficacy; (3) assessment usage, and; (4) any

connections to science learning outcomes.

With this in mind, the overall purpose of doing this study is to determine any connection between schools' respective independent variables (coded variables developed from the teachers' perceptions) and schools' scaled 5th grade state science exam scores. This purpose has been brought to fruition when I developed a multiple regression equation using the aforementioned coded variables (independent variables) developed from the teachers' responses along with schools' respective demographics and combined teacher demographics, and the schools' scaled 5th grade state science exam scores (dependent variable). The specific statistics to be used are discussed later in this chapter.

The two main research questions for this study are:

1. For teachers presently using or have used the "Science Unit Kit Program" in elementary schools which have fully adopted a science kit program (i.e., kits available for all teachers in grades K-5), what are their perceptions regarding:
 - a. levels of science kit usage, including the inquiry-based experiments, assessments and associated science reading, writing and journaling activities;
 - b. perceived value of aspects of the science kits in helping students learn science concepts;
 - c. their confidence levels in teaching elementary school science using the kits as a resource;
 - d. support levels from the school, district and regional math and science center;

- e. quality of professional development from the kit designers;
 - f. any success related to science student learning outcomes; and
 - g. beliefs regarding the teaching of science in elementary school?
2. To what extent can schools' state science assessment scores be predicted from the level of science kit usage by teachers and other related input variables, as controlled by various school and teacher demographic variables?

Research Design

I utilized a quantitative research approach in this study to determine if there is a relationship between various independent and dependent variables. Along these lines, Creswell (2003) stated that, "... if the problem is identifying factors that influence an outcome, the utility of an intervention, or understanding the best predictor of outcomes, then a quantitative approach is best" (p. 21).

A survey was used because it can collect the needed data for this study as described by Groves et al. (2004): "The survey is a systematic method for gathering information from (a sample of) entities for the purpose of constructing quantitative descriptors of the attributes of the larger population of which the entities are members" (p. 4). I chose to use an Internet-based survey because it has many advantages over phone or mail surveys, in that it can be done quickly, cheaply, and effectively (Fricker & Schonlau, 2002).

Population, Sample and Site

The population used in this study was approximately 1,500 kindergarten through 6th grade elementary school teachers throughout a Midwestern state. These teachers, from the schools participating in my study, are on file as presently using or have used, the

“Science Unit Kit Program” developed by the regional mathematics and science center. This population includes teachers within both public and private schools.

The most current e-mail addresses for these teachers were furnished to me by the unit science kit developers at the regional mathematics and science center. After evaluating these databases, I found that they were quite outdated. Therefore, I spent the next two months building a new database from the participating schools listed on the internet.

This regional mathematics and science center is divided into two sections; namely, the high school program and the outreach program. It is from this outreach program that the unit kits were developed. The objective of the “Unit Science Kit Program” is to assist the elementary school teachers in providing their students with good inquiry-based science which matches up with the state’s science standards. Teacher writers develop science curriculum for grades K – 7 and acquire the materials to build four “Unit Science Kits” for each grade. Depending upon grade level, there is the opportunity to instruct with “Unit Science Kits” for the following subject areas: physical science; life science; earth science; and inquiry and technology. Each “Unit Science Kit” includes all the materials to do approximately 20 experiments with the students, along with a teacher’s guide, student journals, relevant reading materials, and assessments. When the “Unit Science Kits” are used as recommended by the designers, the teachers will be comfortable in conducting the inquiry-based lessons because they have been trained in the subject content and the respective experiments. The teachers are not allowed to obtain a kit for their classroom prior to being trained by the kit developers at the regional mathematics and science center. As the students do the experiments, they

record their findings in their student journals for subsequent discourse and evaluation by the class which hopefully answers some of the students' questions and develops more questions for further study. Formative and summative assessments, which are included in each "Unit Science Kit", are used by the teachers when they feel that their students are comfortable with the unit content. Additional reading and writing opportunities are available with the "Unit Science Kits" and are incorporated in the lessons when appropriate. The teachers are expected to complete four kits per year, or one per quarter. When the teacher is finished with a kit, the kits are returned to the regional mathematics and science center for refurbishment and the subsequent kit is delivered to them. The unit kits are updated routinely when new state or national goals are changed. The curricula and the respective supplies for these kits are now being updated to match the new national "Next Generation Science Standards."

When the center initially began, the local districts surrounding the regional mathematics and science center were the ones that bought the unit science kits. As time went on, other districts began to purchase the unit science kits, and now the kits are in over 130 school districts around this Midwestern state. The population included in this study are teachers found in a variety of districts, including private and public schools located in rural, suburban, urban, well funded, and/or poorly funded districts.

It is up to the respective schools within a school district as to which teachers are to use the unit science kits in their classrooms and receive the required training on how to use the kits most effectively with students. Most kit training is done at the regional mathematics and science center but for some distant schools, training is provided at their

school by the regional mathematics and science center trained trainers. These are the teachers who made up the population for this study.

Instrumentation

One part of the data needed for this study will be collected by use of a researcher-developed survey (see Appendix A). Essentially the questions for the teachers center around their experiences with their unit science kits, and their perceived successes with student achievement in the classroom and on the state administered science exam. Questions concerning teachers' beliefs about science in elementary school, support from their school, district and kit developers, and professional developments are also included in the survey. And lastly, the survey collects teacher and school demographics.

The survey has various sections associated with the input variables reflected in the study's framework (a → g). In all but two groups of questions, the respondents used a six point Likert scale in answering the questions: 1 = Strongly Disagree; 2 = Disagree; 3 = Slightly Disagree; 4 = Slightly Agree; 5 = Agree; 6 = Strongly Agree. The two questions not using this Likert scale as previously mentioned are questions six and seven. For the eight responses found in question six, the teachers used a Likert scale for the respective questions: 1 = Never; 2 = Hardly Ever; 3 = Not Very Often; 4 = Some of the Time; 5 = Most of the Time; 6 = Always. For the eight responses found in question seven, the teachers used a Likert scale for the respective questions: 1 = Do Not Use; 2 = Very Limited Value; 3 = Some Value; 4 = Moderate Value; 5 = Significant Value; 6 = Very Valuable. The remainder of the survey consists of additional informational questions and open-ended survey questions that the teachers may choose to complete.

Since this survey is a researcher-generated first time used document, its reliability cannot be checked, but the content validity can (Mora, 2011). Based upon previous research and the development and kit usage by my pilot group, I had a reasonable belief that a pilot group could sufficiently evaluate the content validity of the teacher survey. Therefore this survey was administered to a small group of teachers and administrators who are familiar with the science kits and the resulting comments and concerns were addressed. Specifically, this small pilot group included one staff writer, two kit assemblers, two regional mathematics and science center administrators and three retired teachers who have used the unit science kits in the past.

A second source of data was obtained online, through the mid-western state's Department of Education's website which provides the needed state's 5th grade science exam scores by school, as well as each school's percentage of students enrolled in the National School Lunch program.

Data Collection Procedures

As mentioned previously, after the data collection protocol and tools were approved by HSIRB, the survey was sent out to the participants via an e-mail that has an embedded URL link to the survey (see Appendix B1). Since the developers of the unit science kits have a vested interest in the responses and results of my study, the survey was sent out by the developers on my behalf. This was done for several reasons and explained in the e-mail to the teachers. First, some of the questions on the survey were needed for my research and others were needed for the regional mathematics and science center unit kit developers. Second, when the participating teachers see e-mails and the survey from the regional mathematics and science center, they are familiar with this

organization which should have lead to a higher percentage of completed surveys. With these two reasons being considered, I attempted to use the Social Exchange Theory. Namely, the benefits of completing the survey and its use were explained; the time to complete the survey was explained; the effort to complete it was minimal; and a sense of trust was established prior to the teachers completing the survey (Miller, 2010). The first page of the survey not only asked for the teachers' consent to complete the survey, but assured the teachers that their responses would be kept confidential by both myself and the regional mathematics and science center. It was hoped that by using the Social Exchange Theory, along with the previously mentioned chance for the respondents to win a \$50 gift card for Amazon, encouraged more responses.

As previously mentioned, creation of the survey was done via a program entitled Survey Monkey. After receiving approval from HSIRB, an e-mail was sent to all of the participants containing the survey link. This initial e-mail was sent out from the regional math and science center's curriculum writer's office and therefore reflected the sender as the "Science Unit Kit Program" developer. Subsequently, the Survey Monkey collected data was sent to the e-mail address of the regional math and science center's curriculum writer who initially sent out the surveys. After the initial survey had been sent out, two more follow up requests for completion were sent out on different days of the week within the following four weeks (see Appendices B2 and B3). These follow up requests essentially thanked the teachers who had completed the survey and told them to just ignore this request and asked those who had not, to please consider completing it.

When each teacher entered the Survey Monkey web site containing my survey, they had to read some information about the survey and then indicate if they wished to

complete it. If they decided to do so, they were indicating that they had read and accepted the guidelines for the survey that included the possibility to skip questions they did not want to answer or exit the survey at any time. At the end of the survey, teachers had the opportunity to enter their e-mail address into a drawing to win one of five \$50.00 gift cards to Amazon. Once the study was completed, the data was stored at WMU.

Data Analysis

Once my data was collected, I exported it into SPSS (Statistical Program for the Social Sciences). This program allowed me to use inferential and descriptive statistics to answer my two research questions. In order to help keep the responses on a somewhat even and more meaningful basis, only those schools that have returned two or more surveys had their responses included in this study.

Once the data was collected, one month of the project was devoted to analyzing it. Survey responses were coded to become the independent variables for this study as aggregated to each school, and the dependent variable was each school's scaled 5th grade state science exam scores. As previously mentioned, these scores were obtained on-line from the Michigan Department of Education's web site and reflected each school's scaled 5th grade state science exam scores over the past five years. These five scaled scores were averaged and the calculated average was used as the study's dependent variable (averaged scaled 5th grade state science exam scores for the last five years) for each school in the study. Scaled scores are used rather than the actual scores because there might be differences in the tests themselves from one year to another.

My survey was developed for the teachers to answer questions using a six point Likert scale reflecting Strongly Agree to Strongly Disagree for some questions, Do not

Use to Very Valuable for one question, and Always to Never for one question. Each question's response was given a score from 1 to 6 depending on its response. The positive responses such as Strongly Agree or Always or Very Valuable received a score of 6 and the negative responses such as Strongly Disagree or Never or Do Not Use received a score of 1. On the questions which simply ask for a teacher's years of teaching and years of using the unit kits, the teacher's numerical response was recorded. The question asking about the teacher having a major/minor in science was scored as: 1 = Yes and 0 = No.

Research question #1 asked teachers their perceptions about their teaching of elementary school science and the use of inquiry-based learning while using science kits. Specifically, the survey questions deals with the following teachers' inputs: (a) levels of science kit usage, including the inquiry-based experiments, assessments and associated science reading, writing and journaling activities; (b) perceived value of science kits in students' learning science concepts; (c) their confidence levels in teaching elementary school science; (d) support levels from the school, district and the regional mathematics and science center; (e) amount of professional development from the kit designers; (f) any success related to science student learning outcomes; and (g) beliefs regarding the teaching of science in elementary school?

As previously mentioned, the state's 5th grade science exam scores, along with the one school demographic, percentage of students using the National School Lunch Program, were found on-line.

The statistics for research question #1 included frequencies, means and standard deviations for each survey question.

Research question #2 was answered by the development of a multiple regression equation using the independent variables (the answers to the collapsed seven sections of the survey and the four demographic pieces of data), and the schools' respective scaled 5th grade state science exam scores for the last five years, as the dependent variable.

In order to do the aforementioned statistics for research questions # 1 and #2, I went through the survey and consolidated the related questions. Survey questions related to research question 1 (a → g) are found in various sections throughout the teacher survey and these responses were collapsed and coded into seven independent variables for this study and included in the multiple regression for research question #2. An average of the total scores (mean) collected in the survey for each of the compressed seven sections was used as the new independent variables when developing the overall multiple regression equation that was used to answer research question #2. The remaining four independent variables and the one dependent variable were also coded so they could be used in the multiple regression equation.

A Cronbach's alpha was performed on all of the newly created independent variables in order to look for internal consistency. "A commonly-accepted rule of thumb is that an alpha of 0.7 (some say 0.6) indicates acceptable reliability and 0.8 or higher indicates good reliability. Very high reliability (0.95 or higher) is not necessarily desirable, as this indicates that the items may be entirely redundant" (Zaiontz, 2013, p. 1). In another situation where the alpha value is quite low, Tavakol and Dennick (2011) stated:

A low value of alpha could be due to a low number of questions, poor inter-relatedness between items or heterogeneous constructs. For example if a low

alpha is due to poor correlation between items then some should be revised or discarded. The easiest method to find them is to compute the correlation of each test item with the total score test; items with low correlations (approaching zero) are deleted. (p. 54)

Also, a Pearson Product-Moment Correlation was performed to measure the strength of a linear association between two variables in the study.

Each variable in the multiple regression was composed of an average of all the teachers' responses for each respective coded question. Therefore each independent variable had an average value of 1 thru 6. A spreadsheet of all data collected by Survey Monkey was developed to match the school's name to their respective teachers' responses and their respective school's scaled 5th grade state science exam scores, along with the percentage of students using the National School Lunch Program (obtained online from the State's Department of Education web site). The teachers were grouped by school on the spreadsheet to complete the averaging calculations for each school. This spreadsheet was used to record the respective teacher's answers to the open-ended questions as well.

The multiple regression equation used in this study is:

$$Y_0 = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11}$$

where the new coded variables are: x_1 = level of kit usage; x_2 = perceived value of science kits in students' learning science concepts; x_3 = teacher confidence in teaching science; x_4 = level of support from school, district and the regional math and science center; x_5 = level of support with professional developments provided by the kit designers; x_6 = any success related to science student learning outcomes; x_7 = beliefs

regarding the teaching of science in elementary school; x_8 = years of teaching; x_9 = years using the unit science kits; x_{10} = undergraduate science major/minor; and x_{11} = percentage of students using the National School Lunch Program. The dependent coded variable is y_1 : where y_1 = average five year scaled 5th grade state science exam scores.

This multiple regression equation reflected the percent effect each independent variable had upon the dependent variable. From this equation, one can see the influence of each school's independent variables on their dependent variable (scaled 5th grade state science exam score), while controlling for their teachers' and school's demographics. A significance level of .05 was used in this study.

To do this multiple regression, an adequate number of responses was necessary. An accepted formula for calculating the number of responses necessary for reliable data analysis is: $N > 50 + 8m$ (Sandelowski, 2007), where "N" is the number of responses and "m" is the number of independent variables. For this study the equation would read as: $N > 50 + (8 \times 11)$. Therefore, the number of responses needed in this study was greater than 50 + 88 or 138.

The open-ended questions were analyzed and a summary of these responses were created.

Table 1 shows a cross-walk table which reflects how my questions in the survey align with the respective research questions discussed in Chapter I, and the type of statistical analysis performed on each research question.

Table 1

Cross Walk Presentation of Study Variables

Research Question	Survey Questions	Data Analysis
For teachers in elementary schools which have fully adopted a science kit have fully adopted a science kit program (i.e., kits available for all teachers in grades K-5), what are their perceptions regarding:		
1.a: levels of science kit usage, including the inquiry-based experiments, assessments and associated science reading, writing and journaling activities	1c, 1l, 6, 7, 8, 9, 11a, 1 (letter l)	Descriptive statistics
1.b: perceived value of science kits in students' learning science concepts	1d, 1e, 1f, 11c, 11d	Descriptive statistics
1.c: their confidence levels in teaching elementary school science	1a, 1b, 1g, 1h, 1i, 1j, 11e	Descriptive statistics
1.d: support levels from the school district, principal and the regional math/science center	1k, 1o, 2, 3, 4, 11b	Descriptive statistics
1.e: amount of professional development from the kit designers	5	Descriptive statistics
1.f: any success related to science student learning outcomes	1d, 1e, 1f, 1i, 11c, 11d	Descriptive statistics
1.g: beliefs regarding the teaching of science in elementary school	1m, 1n	Descriptive statistics
2. To what extent can schools' state science assessment scores be predicted from the level of science kit usage by teachers and other related input variables, as controlled by various school and teacher demographic variables?	1- 9, 15c, 16	Multiple regression
Consistencies found in the "Science Unit Kit Program" over the years	11	Descriptive statistics
Additional questions and comments	13, 15a, 15b, 17, 18, 19	Qualitative Summary

Limitations and Delimitations

The delimitations of this study are specific boundaries over which I have control (Ellis & Levy, 2009). The population for this study is a set of all K-6 elementary school teachers who are presently using or have used the “Unit Science Kit Program” in their classrooms. No other teachers were included in the study. Therefore, the results of this study can only be generalized to the participating elementary school teachers. Also, the self-developed survey is a delimitation in this research in that this researcher has decided upon what questions to include in the survey and how to ask them.

The limitations of this study are things over which I have no control. Even though the survey could be considered a delimitation as previously stated, it can also be considered a limitation because I was not able to test my survey for reliability since it is researcher-developed and never been used before. A further limitation is the rate of response and the reasons the teachers did or did not complete the survey. Another limitation to my study is the mobility of both teachers and students who might have moved into or out of the respective schools over the years being studied. And lastly, there is a limitation when there was not an equal number of responders from each school. Under the Data Analysis section, an explanation of my attempt to minimize this limitation is explained by the fact that there needed to be a minimum of two teacher surveys returned by a school in order for that school’s data to be included in this study.

Reflexivity

I have been a teacher at the regional math and science center for the past 23 years. During that time, I have become very familiar with the development of the Unit Science

Kit Program the regional math and science center has designed. I have been consulted from time to time on the explanation of various science concepts used in the unit kits and I am very familiar with not only the unit kits themselves, but also the professional developments and support provided to the teachers using the kits. I have actually participated in several of the teacher professional development meetings. Lastly, I am familiar with some of the schools and teachers implementing the kits and their different beliefs about their kit usage. Such familiarity has allowed me the appropriate knowledge to construct the survey, as well as support from the regional math and science center to distribute the survey.

Chapter III Summary

This chapter explained the methodology I used in collecting my research data and how it was analyzed to answer my two research questions. This quantitative research study is built around a researcher-designed teacher survey to ascertain perceptions about teaching elementary school science through inquiry-based instruction by use of unit science kits. The results of this study allowed me to report the level to which certain aspects of teacher kit usage and teacher beliefs surrounding science education in elementary school can predict a school's 5th grade state science exam scores. Chapter IV will explain and display the results of the collected data and its statistical analysis.

CHAPTER IV

RESULTS

This chapter provides a statistical analysis and explanation of the results collected with the teacher survey used in this study. The teacher survey was developed to collect teachers' perceptions about teaching elementary school science while using a science kits program. These results were analyzed and used to develop a multiple regression equation that could be used by any of the participating schools to understand the specific variances of each independent variable on the dependent variable, the state 5th grade science exam.

Overview of Purpose and Questions

My research was designed to identify the perceptions of teachers about using a science kit program which has been purchased and adopted by their respective school districts, and implemented by the teachers in that respective district. My research questions for this study included the following:

1. For teachers presently using or have used the "Science Unit Kit Program" in elementary schools which have fully adopted a science kit program (i.e., kits available for all teachers in grades K-5), what are their perceptions regarding:
 - a. levels of science kit usage, including the inquiry-based experiments, assessments and associated science reading, writing and journaling activities;
 - b. perceived value of aspects of the science kits in helping students learn science concepts;
 - c. their confidence levels in teaching elementary school science using the kits

- as a resource;
 - d. support levels from the school, district and regional math and science center;
 - e. quality of professional development from the kit designers;
 - f. any success related to science student learning outcomes; and
 - g. beliefs regarding the teaching of science in elementary school?
2. To what extent can schools' state science assessment scores be predicted from the level of science kit usage by teachers and other related input variables, as controlled by various school and teacher demographic variables?

To obtain responses for these two research questions, approximately 1,500 elementary school teachers, identified as using the science kits within over 70 schools throughout a given Midwestern state, were invited to participate in this study. Over a four week period, 4% of the email addresses were identified as incorrect, therefore approximately 1,440 teachers were contacted and asked to participate in the study. The number of teachers that began the survey was 264, but 19 were deleted and therefore, 245 surveys were analyzed. The 19 responses were deleted for one of three reasons. The first was because it was incomplete. While a teacher was taking the survey, they had the option to skip any question they did not want to answer or to stop at any time while taking the survey. If a teacher skipped a question here or there, it was not considered an incomplete survey. In all of the surveys I considered incomplete, the teachers stopped in the middle of the survey where they had to identify their respective school's name. As the survey pointed out on this question, it was essential for the teacher to complete this

question because without it, it was impossible for me to include their responses, along with the responses of the other teachers in that school. The second reason was because it was the only survey from a school (as previously stated in the Chapter III, at least two surveys from a school were required in order for that school to be included in the study). Also, here is where an incomplete survey could possibly disqualify another teacher's response if there was only one completed survey from that school. And, the third reason was because the survey came from a school for which I could not identify either their MEAP score, or their National School Lunch Program (NSLP) percentage or both.

As pointed out by Christian, Dillman, and Smyth (2007), a more successful survey will be achieved when reminder emails are sent out on different days of the week. In this study, after sending out the original survey, I sent out two follow-up reminder emails approximately 10 days apart. The first reminder email was sent out on a Monday and the second one was sent out on a Thursday.

In order to get a good response rate for my survey, a financial incentive was included in the emails which involved the opportunity for five teachers to win a \$50.00 gift certificate from Amazon.

So in summary, 245 surveys from 57 schools were used in the analysis of this research study.

Description of Data

My survey consisted of 21 questions, of which, 11 were closed-ended questions using a Likert scale, one was a "yes/no" response with three sub-questions, three were opened- ended questions asking teachers to share any further information they would like to share, and six were demographic questions including years at your school, gender (not

used in the study – only for the Regional Math/Science Center’s database), school name, years of teaching, years of using the kits, and present grade level/s and past grade level/s (not used in the study – only for the Regional Math/Science Center’s database). In the category of the 11 Likert scale questions, there were 60 sub-questions for the teachers to answer. So all in all, the teachers had 73 questions/sub-questions they could answer.

Table 2 displays the demographic information collected in this study. Since all of the questions were optional, the total numbers by descriptor may not add up to the total number of respondents.

Of note in Table 2 is the big difference in the number of female teachers (214) and male teachers (31). Another difference in demographic data is in the range of “years of teaching.” With the exception of teachers with 5 years or less of experience, the distribution within the remaining categories are nearly the same, with the 6-10 category frequency being the largest. Along with the “years of teaching” goes the “years using the kits.” The largest percentage of teachers using the kits fell among the 0-5 category and 6-10 category, while the smallest percentages were in the 16–20 and 21+ categories. This data also displays that over 40% of the participating teachers have an undergraduate major or minor in science. The categories of “present grade/s teaching” shows that the largest grouping was in the 2nd and 3rd grade categories while the remaining grades were essentially the same, with the exception of the 6th grade category having the lowest number of teachers. “Past grade/s taught” had the largest number of teachers within the K, 1st, 2nd, 3rd and 4th grade categories.

Table 2

Respondent Demographic Information (n=245)

Descriptors	Frequency	%
Gender		
Male	31	12.6
Female	214	87.3
Years of Teaching		
0-5	26	10.8
6-10	63	26.1
11-15	47	19.5
16-20	55	22.4
20+	50	20.7
Years of using Kits		
0-5	80	33.2
6-10	90	37.3
11-15	45	18.7
16-20	20	8.30
21+	6	2.50
Science Major/Minor		
Yes	97	41.1
No	139	58.9
Present Grade/s Teaching		
K	32	N/A*
1 st	37	N/A*
2 nd	51	N/A*
3 rd	49	N/A*
4 th	33	N/A*
5 th	36	N/A*
6 th	16	N/A*
Past Grade/s Taught		
K	51	N/A*
1 st	64	N/A*
2 nd	61	N/A*
3 rd	67	N/A*
4 th	54	N/A*
5 th	38	N/A*
6 th	15	N/A*

Note: Not all respondents responded to all items.

* Grade/s Teaching and Grade/s Taught – % is N/A because some teachers teach or have taught multiple grades.

Research Question 1

The overall purpose of doing this study was to determine the effect of each school's respective independent variables (coded variables developed from the survey

indicating the teachers' perceptions of teaching elementary school science with the use of science kits) on that school's 5th grade state science exam score.

The information needed to address the seven sub categories (1a thru 1g) under Research Question 1 are found within various questions throughout the survey. The combination of these survey responses, as arranged on the *Cross Walk* Table, will be addressed later in Chapter IV, but initially I will display the results from the 60 Likert scale questions.

Table 3 displays the results of survey questions that are about kit usage, namely: confidence in teaching science, better at teaching science, students love doing the experiments, great success in meeting outcomes, consistent growth in student understanding, growth in student excitement, easy to write lesson plans, easy to complete lessons, maintaining student attention, enjoyable teaching science, sufficient amount of materials, grade level appropriate reading, importance of having a strong science program, and school monitoring of the program. The items are listed from the highest to lowest mean.

The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, and 6=strongly agree.

The two highest rated items showed that most of the respondents agreed or strongly agreed that it is very important to have a strong science program in elementary school at the rate of 5.43 and to integrate literacy and math into science lessons at the rate of 5.38. The two lowest rated items showed that the respondents felt that many of the lessons contained in the kits were too long for one class period with a rating of 3.49 and

that the implementation and use of the kit program is not well monitored in their schools with a rating of 3.30. The remaining survey questions with neither very positive, nor very negative.

Table 3

Science Kit Usage, Contents and Feelings about Teaching Elementary School Science (n=245)

<i>In using the Science Unit Program, I feel</i>	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree	Total	Weighted Average
it is very important to have a strong science program in the elementary school	0.00% 0	1.65% 4	1.65% 4	7.44% 18	30.17% 73	59.09% 143	242	5.43
it is very important to integrate literacy and math into my science lessons and vice versa	0.00% 0	0.41% 1	2.45% 6	10.61% 26	31.43% 77	55.10% 135	245	5.38
very confident in teaching science in my classroom	1.63% 4	2.86% 7	5.71% 14	17.14% 42	47.35% 116	25.31% 62	245	4.82
my students love doing the experiments contained in the kits	0.41% 1	2.45% 6	5.71% 14	22.45% 55	43.67% 107	25.31% 62	245	4.82
the kits contains sufficient amount of materials for each experiment	1.62% 4	3.66% 9	7.32% 18	13.42% 33	48.78% 120	25.20% 62	246	4.80
I can better teach science to my students	2.03% 5	3.25% 8	6.91% 17	21.95% 54	43.90% 108	21.95% 54	246	4.68
there is a very consistent growth in students' excitement about learning science	0.82% 2	3.27% 8	11.02% 27	25.71% 63	42.86% 105	16.33% 40	245	4.56
it is very easy to write my lesson plans	4.49% 11	4.90% 12	8.57% 21	19.59% 48	40.82% 100	21.63% 53	245	4.52
it is an enjoyable teaching experience	3.27% 8	4.08% 10	12.65% 31	27.76% 68	38.78% 95	13.47% 33	245	4.35
there is very consistent growth in students' understanding of science concepts	1.63% 4	7.35% 18	8.16% 20	33.47% 82	41.63% 102	7.76% 19	245	4.29

Table 3 - Continued

<i>In using the Science Unit Program, I feel</i>	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree	Total	Weighted Average
my students experience great success meeting the student outcomes for science	1.63% 4	7.35% 18	12.24% 30	30.20% 74	40.41% 99	8.16% 20	245	4.25
it is very easy to maintain the students' attention throughout the lessons	2.05% 5	4.51% 11	12.30% 30	38.11% 93	34.84% 85	8.20% 20	244	4.24
the reading and writing for each kit is grade level appropriate	3.70% 9	7.00% 17	15.23% 37	27.98% 68	39.09% 95	7.00% 17	243	4.13
it is very easy to complete each lesson within the allotted time	11.93% 29	13.17% 32	20.99% 51	27.98% 68	19.75% 48	6.17% 15	243	3.49
its implementation is monitored in my building to ensure I am using all recommended elements of the program	10.61% 26	23.27% 57	19.18% 47	24.90% 61	16.73% 41	5.31% 13	245	3.30

Note: Not all respondents responded to all items

Table 4 displays the results of survey questions that deal with support items that the respective school districts have provided their elementary school teachers. The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, and 6=strongly agree.

The responses related to support questions were not very positive. The weighted average for the district providing a comprehensive science curriculum for the teachers to use was 4.31, while the weighted average for the district providing the sufficient additional training for teaching science in the classroom beyond the unit kit training was even lower at 3.18. These results suggest that the participating teachers, on the average,

do not feel that their respective school districts provide sufficient support with their science curriculum and definitely, do not provide the funds for them to receive additional training beyond the kit training they presently receive.

Table 4

District Support for Curriculum and Training (n=245)

<i>My district has provided:</i>	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree	Total	Weighted Average
a comprehensive science curriculum for me to use with my students	2.86% 7	9.39% 23	11.84% 29	20.82% 51	40.00% 98	15.10% 37	245	4.31
sufficient additional training for teaching science in my classroom beyond the unit kit training	15.23% 37	22.63% 55	21.81% 53	16.05% 39	17.70% 43	6.58% 16	243	3.18

Note: Not all respondents responded to all items.

Table 5 displays the teacher responses to survey questions which deal with the types of support provided by the teachers' respective principals. None of the weighted averages were very positive ranging from 3.83 to 3.05. The strongest responses involved teacher encouragement with a weighted average of 3.83 and supply of trade books of 3.82. Providing money for teacher training, beyond the kit training they presently receive, had the lowest weighted average of 3.05. These results suggest that the participating teachers do not feel that their respective principals are providing a sufficient amount of support needed in their classrooms.

Table 5

Principal Support for Teacher Mentoring, Encouragement, Time and Money (n=245)

<i>My principal has provided</i>	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree	Total	Weighted Average
sufficient encouragement for my science teaching	6.15% 15	16.80% 41	13.52% 33	23.77% 58	30.74% 75	9.02% 2	244	3.83
all needed literacy trade books that go along with the science kits	9.41% 23	15.23% 37	13.99% 34	19.75% 48	27.98% 68	13.58% 33	243	3.82
sufficient mentoring or a mentor for my science teaching	10.29% 25	27.16% 66	18.93% 46	16.46% 40	21.81% 55	5.35% 13	243	3.28
sufficient time to discuss my science teaching	10.70% 26	25.93% 63	18.11% 44	22.63% 55	17.70% 43	4.94% 12	243	3.26
sufficient money for attending other science training	16.12% 39	26.45% 64	19.42% 47	16.53% 40	16.94% 41	4.55% 11	243	3.05

Note: Not all respondents responded to all items.

Table 6 shows the teacher responses to survey questions dealing with services provided by the regional math/science center. The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, and 6=strongly agree.

Timely support had fairly good weighted averages. Timely delivery of missing equipment was 4.74; timely return of text and phone calls was also 4.74; timely delivery of kits was 4.72, while the professional developments had a low weighted average of 4.14. These results suggest that the regional math/science center is quite good at providing what the teachers need on a timely basis, but needs to address the concerns that teachers have about the present professional development program provided on the kits.

Table 6

Regional Math and Science Center Provisions of Kit Supplies and Professional Development (n=245)

<i>The regional math/science center has provided</i>	Strongly Disagree	Disagree	Slightly Disagree	Slightly agree	Agree	Strongly Agree	Total	Weighted Average
timely delivery of any missing program materials	0.43% 1	0.43% 1	3.04% 7	6.96% 16	52.17% 120	36.96% 85	230	4.74
timely return of text or phone requests for assistance	0.00% 0	0.92% 2	2.29% 5	10.09% 22	54.13% 118	32.57% 71	218	4.74
timely delivery of the science units	0.42% 1	0.84% 2	2.11% 5	8.02% 19	48.10% 114	40.51% 96	237	4.72
quality professional development	2.60% 6	6.06% 14	9.52% 22	24.68% 57	41.13% 95	16.02% 37	231	4.14

Note: Not all respondents responded to all items.

Within Table 7, the teacher responses about professional development training are addressed. The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, and 6=strongly agree.

The weighted average of the responses were slightly negative to moderately positive. The timeliness of the professional developments received the highest weighted average of 4.50, while the category of excellence for the professional developments received the lowest weighted average of 4.15. Supportiveness (4.31), ease of attendance (4.35), structured for easy learning (4.36), and sufficient in content (4.36), received weighted averages between the timeliness (4.50), and excellence (4.15) of the professional development provided by the regional math/science center. These results

suggest that the professional development is fairly supportive, but needs to improve and move toward a good to excellent product in order to provide what the teachers feel they need to meet their needs.

Table 7

Regional Math and Science Center Provisions of Professional Development (n-245)

<i>The Professional Development I have Received on the "Science Unit Kit Program" has been</i>	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree	Total	Weighted Average
very timely	1.70% 4	4.26% 10	8.94% 21	25.53% 60	46.38% 109	13.19% 31	235	4.50
constructed in a way that makes the material easy to understand	4.31% 10	4.31% 10	10.78% 25	24.14% 56	44.83% 104	11.64% 27	232	4.36
very easy to attend	2.13% 5	7.23% 17	10.21% 24	25.53% 60	43.40% 102	11.49% 27	235	4.35
very supportive of my needs	2.97% 7	6.78% 16	11.02% 26	24.15% 57	45.76% 108	9.32% 22	236	4.31
sufficient to meet my needs	5.11% 12	5.53% 13	14.04% 33	22.55% 53	41.28% 97	11.49% 27	235	4.24
excellent	4.27% 10	5.98% 14	13.25% 31	32.48% 76	35.04% 82	8.97% 21	234	4.15

Note: Not all respondents responded to all items.

Table 8 displays the teacher responses to survey questions involving the use of the inquiry-based experiments, kit assessments, the use of pre-reading and pre-writing materials, reading integration-time, and the use of industrial and student journals. The survey items used to address these questions were based on a Likert scale with categories

of measurement that included: 1=never, 2=hardly ever, 3=not very often, 4=some of the time, 5=most of the time, and 6=always.

The weighted averages for these questions had a wide range from a low of 3.02 for the reading of industrial journals to a high of 5.05 for the use of student journals. The use of inquiry-based experiments and the use of summative assessments also received fairly high weighted averages of 4.82 and 4.77 respectively. The weighted average for the use of the formative assessments was 4.48, lower than its counterpart of summative assessment use at 4.77. And, pre-reading and pre-writing times weighted averages were quite low at 4.08 and 3.91 respectively. This data suggest that the teachers are quite happy with the use of the inquiry-based experiments and the student journals. It also seems that the teachers do not use the industrial journals, the pre-reading times and pre-writing times very often. The information here appears to show that the teachers do have some interest in using reading integration time and summative assessments, but less interest in using the formative assessments found in the kits.

Table 8

Science Assessments and Science Reading Frequency (n-245))

<i>I use</i>	Never	Hardly Ever	Not Very Often	Some of the Time	Most of the Time	Always	Total	Weighted Average
student journals	1.66% 4	2.90% 7	3.73% 9	14.94% 36	34.44% 83	42.32% 102	241	5.05
inquiry-based experiments	0.41% 1	2.87% 7	3.69% 9	26.23% 64	40.98% 100	25.82% 63	244	4.82
summative assessments	4.55% 11	5.37% 13	5.37% 13	18.60% 45	25.21% 61	40.91% 99	244	4.77

Table 8 –continued

<i>I use</i>	Never	Hardly Ever	Not Very Often	Some of the Time	Most of the Time	Always	Total	Weighted Average
formative assessments	2.07% 5	8.26% 20	6.20% 15	25.10% 68	33.88% 82	21.49% 52	242	4.48
recommended reading integration time	2.07% 5	4.15% 10	10.3% 25	34.02% 82	32.78% 79	16.60% 40	240	4.41
recommended pre- reading time	3.33% 8	7.92% 19	15.00% 36	36.25% 87	26.25% 63	11.25% 27	240	4.08
recommended pre- writing time	4.20% 10	8.40% 20	18.49% 44	38.24% 91	22.69% 54	7.98% 19	238	3.91
industrial journals	30.45% 67	0.91% 24	15.91% 35	18.64% 41	17.27% 38	6.82% 15	220	3.02

Note: Not all respondents responded to all items.

Table 9 displays the teacher responses to survey questions which ask the value of the items associated with the science kits. These are the use of the inquiry-based experiments, kit assessments, the use of pre-reading and pre-writing materials, reading integration-time, and the use of industrial and student journals. The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=do not use, 2=very limited value, 3=some value, 4=moderate value, 5=significant value, and 6=very valuable.

The range between the highest and lowest weighted averages was quite wide, from a 4.94 for the value of the inquiry-based experiments to 2.86 for the value of using the industrial journals found in the kits. Weighted averages in the 4.00 range were found with the following: formative assessments, reading integration time, and student journals. Weighted averages in the 3.00 range were found with the summative assessments, pre-

reading time, and pre-writing time. This data suggest that the teachers place very little value on the use of industrial journals and only slightly more value on the recommended pre-reading time, pre-writing time, and summative assessments. The inquiry-based experiments and student journals had the greatest value placed upon them by the teachers. The difference between the weighted averages for the value of the formative assessment (4.07) and the value of the summative assessments (3.94) is quite small, but the formative assessments have a little higher weighted average. Table 9 shows that even though the teachers have placed a slightly greater value on the formative assessments, they use them less frequently than the summative assessments as shown in Table 8. Therefore, the data suggest that the teachers value the formative assessments a little more than the summative assessments, but use them less as shown in Table 8.

Table 9

Science Experiments, Assessments and Science Reading Value (n=245)

<i>For these "Science Unit Program" elements, how valuable is each in helping your students learn science</i>	Do not use	Very limited value	Some value	Moderate value	Significant value	Very valuable	Total	Weighted Average
inquiry-based experiments	1.26% 3	1.67% 4	7.11% 17	17.15% 41	37.66% 90	35.15% 84	239	4.94
student journals	2.11% 5	3.80% 9	10.55% 25	22.36% 53	35.44% 84	25.74% 61	237	4.62
recommended reading integration-time	4.24% 10	3.39% 8	17.37% 41	26.27% 62	32.63% 77	16.10% 38	236	4.28
formative assessments	3.39% 8	8.05% 19	19.07% 45	27.97% 66	30.93% 73	10.59% 25	236	4.07

Table 9 - continued

<i>For these "Science Unit Program" elements, how valuable is each in helping your students learn science</i>	Do not use	Very Limited value	Some value	Moderate value	Significant value	Very valuable	Total Weighted Average
summative assessments	6.30% 15	10.08% 24	16.81% 40	27.72% 66	28.57% 68	10.50% 25	238 3.94
recommended pre-reading time	7.50 18	7.08% 17	21.25% 51	32.92% 79	23.33% 56	7.92% 19	240 3.81
recommended pre-writing time	8.47% 20	8.05% 19	21.61% 51	30.08% 71	24.58% 58	7.20% 17	236 3.76
industrial journals	32.88% 72	10.96% 24	16.89% 37	21.46% 47	12.33% 27	5.48% 12	219 2.86

Note: Not all respondents responded to all items.

Table 10 shows the teacher responses for survey questions which dealt with the use of the assessments found in the kits. The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, and 6=strongly agree.

The weighted averages were not very positive. They ranged from a low weighted average of 4.02 for the expectations to use the assessments to a high of 4.27 for how the assessments matched the material covered in the unit. The other question, with a weighted average of 4.13, dealt with how the assessments and student understanding matched, was also quite low. There was little spread in these responses which were quite

low. This data possibly suggest that the teachers in this study do not attribute a great deal of credibility to the assessments found in the kits. The corresponding weighted averages for these assessments, found in Table 8 and Table 9, also possibly indicates that lack of credibility.

Table 10

Use of Assessments (n=245)

<i>For the formative and Summative assessments Provided with each "Science Unit"</i>	Strongly Disagree	Disagree	Slightly disagree	Slightly Agree	Agree	Strongly agree	Total	Weighted Average
the assessments match very closely with the material covered in the unit	2.09% 5	3.35% 8	10.46% 25	23.43% 56	46.86% 112	13.81% 33	239	4.27
there is a very close relationship between the assessments and students' understanding	3.75% 9	6.25% 15	10.42% 25	23.33% 56	46.25% 111	10.00% 24	240	4.13
there is a strong expectation for me to use them	3.29% 8	7.82% 19	10.29% 25	15.64% 38	37.04% 90	25.93% 63	243	4.02

Note: Not all respondents responded to all items.

Table 11 displays the responses for survey questions dealing with the use of student journals contained in the kits. The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, and 6=strongly agree.

The weighted averages for these questions were fairly low. The weighted averages ranged from a low of 3.89 for the quality of work found in the student journals, to a high of 4.41 for the expectations to use the student journals. The other weighted

average of 4.39 was close to the expectation weighted average. The weighted average for these expectations to use the student journals is rather low, suggesting that there is possibly not that much administrative emphasis put on their value. The completeness and quality of work found in the journals also have rather low weighted averages which might suggest various problems with the journals, such as they are not very exciting for the students, inappropriate reading levels found in the journals, and teachers attitudes about the use of the journals, as found in previous survey questions.

Table 11

Use of Student Journals (n=245)

<i>For the student journals Provided in each "Science Unit," I find</i>	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly agree	Total	Weighted Average
there is a strong expectation for me to use them	4.53% 11	10.29% 25	9.05% 22	18.52% 45	30.86% 75	26.75% 65	243	4.41
that most of my students complete them	7.00% 17	4.94% 12	7.82% 19	21.40% 52	39.92% 97	18.93% 46	243	4.39
that most of my students enter quality work in their journals	5.76% 14	10.29% 25	14.81% 36	33.33% 81	29.63% 72	6.17% 15	243	3.89

Note: Not all respondents responded to all items.

Table 12 shows the responses of survey questions which dealt with consistent growth of the "Science Unit Program." The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, and 6=strongly agree.

The weighted averages were quite low, ranging from a low of 3.68 for both kit implementation and support for the science program, to a high of only 4.08 for student

excitement about science. The remaining questions' weighted averages fell in between these aforementioned weighted averages. Student understanding had a weighted average of 3.83 and teacher confidence had a weighted average of 3.95.

The responses for these questions were not provided by all of the participating teachers. They were only provided by the teachers who had been teaching at their present school for three years or more. So, the questions are looking for trends of consistent growth in various areas. The weighted averages for these areas were quite low for consistent growth. Only the weighted average for student excitement was barely in the 4.00 range. All the remaining areas of consistent growth were in the very low 3.00 range. These responses possibly suggest that most of the experienced teachers have not seen very much positive growth in the "Science Unit Program." This trend could be for many reasons which I will discuss in Chapter V.

Table 12

Areas of Consistent Growth (n=211)

<i>During my time at my present school, I have seen very consistent growth in</i>	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree	Total	Weighted Average
students' excitement about science	2.84% 6	6.64% 14	11.85% 25	26.07% 55	40.76% 86	11.85% 25	211	4.08
teacher's self confidence in using the "Science Unit Program"	4.27% 9	8.06% 17	11.37% 24	31.28% 66	35.55% 75	9.48% 20	211	3.95
students' understanding of science	5.24% 11	9.05% 19	13.81% 29	33.81% 71	31.43% 66	6.67% 14	210	3.83

Table 12 – continued

<i>During my time at my present school, I have seen very consistent growth in</i>	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree	Total	Weighted Average
"Science Unit Program" implementation	6.64% 14	15.64% 33	11.85% 25	28.44% 60	32.70% 69	4.74% 10	211	3.68
support for the "Science Unit Program"	7.11% 15	11.85% 25	16.59% 35	28.91% 61	31.28% 66	4.27% 9	211	3.68

Note: Not all respondents responded to all items. (n=211) because only teachers with 3 years or more of experience at their present school completed these questions.

Table 13 displays the teacher responses for the survey question which deals with the perceived changes, for the last 3-5 years, in science teaching time. The survey items used to address these questions were based on a Likert scale with six categories of measurement that included: 1=decreased a great deal, 2=decreased some, 3=decreased minimally but essentially the same, 4=increased minimally but essentially the same, 5=increased some, and 6=increased a great deal.

The weighted average for this question of 2.8 is the lowest of any question in the survey. The largest number of responses was under the negative descriptors of “decreased a great deal” and “decreased some,” while the smallest number of responses was under the descriptors “increased some” and “increased a great deal.” These responses might suggest that as far as these teachers are concerned, time to teach science in elementary school is decreasing for them. Therefore, since there are only so many hours in the school day, the time being taken away from science must be given to other subject areas such as ELA, math, and social studies.

Table 13

Change in Science Teaching Time Over the Last 3-5 years (n=209)

	Decreased a great deal	Decreased some	Decreased minimally but essentially the same	Increased minimally but essentially the same	Increased some	Increased a great deal	Total	Weighted Average
<i>amount of time to teach science each week changed in the past 3-5 years</i>	25.8% 54	25.4% 53	13.9% 29	15.8% 33	13.4% 28	5.7% 12	209	2.8

Note: Not all respondents responded to all items.(n=209) because only teachers with 3 years or more of experience at their present school completed this question.

Opened-ended Responses

There were three open-ended questions in my teacher survey. The first one asked if the teacher had received any training in the “Next Generation Science Standards” (NGSS). The second asked about the teacher’s favorite lesson or lessons to teach, and the third one asked the teachers to list any comment or concerns about using the science kits. With the question about receiving training on the NGSS, only 8% of the teachers responded in the affirmative.

With the open-ended questions concerning the teacher’s favorite unit to teach and comments about using the “Science Unit Program,” there was a 64% and 58% response rate respectively. A summary of these open-ended “favorite unit” questions is as follows in Table 14.

Table 14

Regional Math and Science Center Kit Titles with Respondents' Favorite Ones (n=157)

Units	Frequency
<u>Kindergarten</u>	
Science Unit 1 - Senses – KPS1	14
Science Unit 2 - Kindergarten in Motion – KPS2	0
Science Unit 3 - My Earth – KES	4
Science Unit 4 - Is It Living? – KLS	10
<u>First Grade</u>	
Science Unit 1 - Sorting Things Out – 1PS	0
Science Unit 2 & 3 - Weather Watchers – 1ES	8
Science Unit 4 - An Animal's Life – 1LS	9
<u>Second Grade</u>	
Science Unit 1 - Measuring Matters – 2PS	5
Science Unit 2 & 3 - Earth's Land and Water – 2ES	14
Science Unit 4 - A Plant's Life – 2LS	9
<u>Third Grade</u>	
Science Unit 1 - Changes in Motion – 3PS1	9
Science Unit 2 - Light and Sound – 3PS2	8
Science Unit 3 - Earth and Me – 3ES	5
Science Unit 4 - Organisms Have Character – 3LS	4
<u>Fourth Grade</u>	
Science Unit 1 - Energy Transfer – 4PS1	10
Science Unit 2 - States of Matter – 4PS2	6
Science Unit 3 - The View From the Earth – 4ES	1
Science Unit 4 - Organisms in Their Environment – 4LS	7
<u>Fifth Grade</u>	
Science Unit 1 & 2 - Forces and Motion – 5PS	14
Science Unit 3 - Objects in the Sky – 5ES	6
Science Unit 4 - Systems and Survival – 5LS	3
<u>Sixth Grade</u>	
Science Unit 1 - Energetic Connections – 6PS	5
Science Unit 2 - The Planet Rock – 6ES1	4
Science Unit 3 - Earth: Yesterday, Today, and Tomorrow – 6ES2	2
Science Unit 4 - Energy in an Ecosystem – 6LS	0

Key: Unit Labels start with grade followed by any of these following letters: PS-Physical Science, ES-Earth Science, LS – Life Science.

The most popular unit responses were recorded with the number of teachers responding to the respective units as: Kindergarten – Senses (14), 2nd grade – Earth’s Land and Water (14), 5th grade- Force and Motion (14), 4th – Energy Transfer (10), Kindergarten – Is it Living? (10), 1st Grade – An Animal’s Life (9), 2nd grade – A Plant’s Life (9), 3rd – Changes in Motion (9).

Table 15 reports some of the more important concerns and opinions that some of the 245 participating teachers shared with me. After reviewing each issue, I found they fell into nine major categories of concerns, namely: time to teach science, kit materials, student journals, love for the kits, animal and plants in the kits, assessments, updating the kits, teacher manuals, and professional development training.

Table 15

Concerns and Opinions from Participating Teachers (n=245)

Comments and Opinions	Frequency	%
Time to Teach Science	46	18.8
Kit Materials	16	6.6
Student Journals	14	5.7
Love for the Kits	9	3.7
Animals and Plants in the Kits	9	3.7
Assessments	7	2.9
Updating the Kits	7	2.9
Teacher Manuals	7	2.9
Professional Development Training	3	1.2

Note: Not all respondents provided their personal comments or opinions.

Time to teach the science lessons was addressed more than any other category. Many of the teachers just feel that the lessons are too long to be completed in one classroom lesson and this is exasperated by the fact that their time to teach science is continuing to be cut in most elementary schools. One teacher expresses his/her frustration in this matter by stating, "I have very little time to teach science. When I do, I need to trim lessons to fit into very short time periods." Another teachers stated that, "We are required to focus on language arts and math, and we only have about 45 minutes, 2-3 times a week, available for science. It makes it very difficult to teach the units as they were intended." Lastly, when discussing the time to teach science, one teacher echoed the concerns of many by stating, "I am very concerned that science kits have been put on the back burner in terms of instruction. The focus is reading and math and we have basically been told that these subject areas take precedent because if students can read, then they can read to learn about science."

Approximately 6.6% of the responding teachers were concerned with the materials found in the kits. These concerns range from not enough materials in the kits, to what they felt were cheap and breakable supplies found in the kits, to multiple comments about the student journals found in the kits. On this topic, one teacher stated that, "Some of the materials are used year after year and not replaced. Some of the materials are cheap and break easily." Another teacher stated that, "We get our kits now from the district with most of the materials in them. It's not enough. We have to supplement them with our own money if we want enough." Another concern about the kit content was that it did not contain any materials to use with students when they return

for an illness. That teacher stated that, “It is next to impossible to make up lessons for absent students.”

Fourteen teachers provided their comments about the student journals found in the kits. Some of the comments ranged from they are too difficult to complete in the lower grades, to once the lesson is over, there is not enough time to do the journal work, to the fact that the student journals are worthless. One teacher responded by stating, “The student journals are nearly useless.” Another teacher responded with this comment: “Due to time limits and the length of the lessons, there is not enough time to do a great job doing the lesson and journal work in the same day.” All in all, most of the comments provided by the teachers concerning the use of the student journals were quite negative.

Other teachers responded with very positive comments about their love for the kits. One teacher stated, “Love the program!” Another stated, “The investigations are great.” And lastly, one teacher stated that, “I do appreciate the science units though, especially since they go along with the Common Core.”

Even though many teachers like having the little animal critters and plants in the classroom, there are some teachers who are not very excited about having them in the classrooms. One of the teachers stated that, “I hate the worms. They die and stink up my room. Hate them!!!!” Another teacher offered a possible solution to this dislike of classroom animals by saying, “There are many online sources for animal observation where we don't have to have live animals in the classroom (per the Systems and Survival unit) that may or may not have a home afterward.”

Seven teacher provided comments about the assessments found in the kits. One teacher provided a possible solution for the cumulative assessments found in the kits.

That teacher stated that, “I would like more formative assessments embedded into the units. I would like progress check points and study guides leading up to the summative assessment.” Another teacher responded by stating that, “The assessments are too wordy, very overwhelming for my low readers, although they do cover the material, the questions just contain too much information.” And lastly, one teacher stated that, “The investigations are great. The students are engaged and like working with and learning from the materials. However, I adjust most of the investigations to match the summative assessment. The goal of the investigation doesn't always match what is being assessed.”

Several teachers made comments about updating the kits. One comment was, “I think that the kits are outdated, they should have digital books, experiments that can be done on ipads/chromebooks, videos, extended learning opportunities, and book lists for kids that want to learn more.” Several teachers agreed with one teacher’s comments about incorporating more technology in the kits. That teacher stated that, “I would love to see more technology based lessons.” Also along this line, one teacher stated that, “Having an online component would be excellent with links, videos and so on.”

Seven teachers commented about the teacher manuals found in the kits. One stated that, “The length of time it takes to read through the lesson plans is astronomical. The teacher manual is not user friendly.” One teacher stated that the teacher manuals are, “too wordy.” And lastly, another teacher stated that, “It would be helpful if the kits came with a new teacher journal each time so that you can use it with your students.”

The last comment/opinion category dealt with the professional development training. Only negative comments about the professional development training they received at the regional math and science center were received. One teacher stated that,

I wished there would be kit specific training. All of the training I've received through the regional math and science center was a waste of time. They never took the kits out and went through experiments or ideas of how to engage or trouble shoot. It would have been awesome to do some of the experiments and let teachers feel comfortable with the kits. Explain a bit of what's in the kits and why.

Another teacher stated that, "I need more in-depth training in each kit." Lastly, another teacher stated that, "The training for each grade level is not needed when you change grade levels. This has created a negative attitude towards the implementation of the program."

In conclusion, most of the comments offered about the program appeared to be of the negative type. Many of these comments seem to show a general teacher frustration for teaching science in elementary school even when they are provided with the kits. On the other hand, some of the teachers love them and feel they cannot teach elementary school science without them.

These comments and concerns are just a few that I have recorded from all the teacher responses. Please see all of these combined "favorite units to teach" and "comments" in Attachment D.

Research Question 2

The second research question queried to what extent can schools' state science assessment scores be predicted from the level of science kit usage by teachers and other related input variables, as controlled by various school and teacher demographic variables?

The data assimilated for this question is represented in several tables. The data was analyzed by the use of statistical programs SPSS and SAS and a multiple regression was performed.

Throughout this Chapter IV, the assumptions of multiple regressions are addressed. The first assumption addressed is sample size. In Chapter III, sample size was calculated using the equation $N > 50 + 8$ (# of independent variables) or $50 + (8 \times 11) = 138$. Initially I thought this study met the requirement of sample size since there were 245 responses and only 138 were required, but now that the data has been collected and analyzed, I see that this calculation was incorrectly done for this research project. Therefore, this miscalculation may affect the power of the multiple regression and therefore may diminish the ability to find real differences in the data. In actuality, the number of independent variables is not 11 as originally proposed, but only four after deleting seven for various statistically reasons. And for the purpose of calculating the multiple regression, I cannot say that I received 245 responses, but can only say that the data collected from the 245 teachers was collapsed into the data for 57 schools representing the sample size. Therefore, the calculation should read:

$N > 50 + 8$ (# of independent variables) or $N > 50 + (8 \times 4) = 82$. But there are others who report their ways to calculate sample size. Hall (1995) suggested that when calculating sample size, a good rule of thumb to go by is that the sample size should be at least 50 more than the number of independent variables. Therefore with using Hall's rule of thumb, my sample size calculation would be $50 + 4 = 54$. Now since my number of responses is 57, and I needed 82 with my first calculation and I need 54 for my second calculation, I feel that my sample size is adequate and does not affect the power of the

multiple regression. Therefore I do not have a situation with a low power which causes me to not necessarily know the reason for rejecting data. So I do not need to ask myself if the reason for rejection was because the data did not provide any real contributions to the model, or because of the small power of the test. Pallant (2013) stated that when we have a large number like 100 or more, power is not affected. She goes on to say that when the number is low such as 20, the researcher may want to reconsider their alpha value and change it from .05 to .10. Since my sample size appears to be adequate, I kept my alpha level at .05.

To begin my analysis for research question 2, I collapsed all of the survey questions, which used a Likert scale, into seven different new variables that address research question 2. The collapsing process was as follows: 29 survey questions were collapsed into a new variable labeled as kit usage; five survey questions were collapsed into a new variable labeled value of the science kits; seven survey questions were collapsed in a new variable labeled teacher confidence level; 15 survey questions were collapsed into a new variable labeled teacher support level; six survey questions were collapsed into a new variable labeled professional development; six survey questions were collapsed into a new variable labeled student science learning success; and two survey questions were collapsed into a new variable labeled teacher beliefs about science education.

As stated in Chapter III, a Cronbach's alpha was then performed on all of the newly created independent variables in order to look for internal consistency. "A commonly-accepted rule of thumb is that an alpha of 0.7 (some say 0.6) indicates acceptable reliability and 0.8 or higher indicates good reliability. Very high reliability

(0.95 or higher) is not necessarily desirable, as this indicates that the items may be entirely redundant” (Zaiontz, 2013, p. 1).

My collapsed data showed the following Cronbach’s alpha results which are all .70 or higher: level of kit usage (.932); value of the science kits (.933); teacher confidence levels (.877); teacher support level (.850); professional development (.947); student science learning success (.933); beliefs about science education (.767). The Cronbach’s alpha analysis is found in Table 16.

Table 16

Cronbach’s Alpha: Collapsed Likert Survey Questions

New variable used in further analyses	Collapsed items in questions	Valid N (%)	Cronbach’s Alpha
level of kit usage	29	56 (98.2)	.932
value of science kits	5	57 (100)	.933
teacher confidence level	7	57 (100)	.877
teacher support level	15	54 (947)	.850
professional development	6	57 (100)	.947
student science learning success	6	57 (100)	.933
teacher beliefs about science education	2	57 (100)	.767

Note: Not all participant responses are included in the Cronbach’s alpha if they did not respond to an item.

Since my research is investigating if there is a correlation between various components of the “Science Unit Program” and the 5th grade state science exam scores (MEAP), I performed a Pearson Product-Moment Correlation on my data. Initially I performed the test on all 11 independent variables and the one dependent variable. After analyzing the results, I developed Figure 2 which reflects the dependent variable and the four independent variables that had any significant correlation with that dependent variable (MEAP).

Lund and Lund (2013) explains a Pearson Product-Moment Correlation by stating:

The Pearson product-moment correlation coefficient (or Pearson correlation coefficient, for short) is a measure of the strength of a linear association between two variables and is denoted by r . Basically, a Pearson product-moment correlation attempts to draw a line of best fit through the data of two variables, and the Pearson correlation coefficient, r , indicates how far away all these data points are to this line of best fit (how well the data points fit this new model/line of best fit). (p. 1)

Significant Pearson Product-Moment Correlation Coefficients

	MEAP	teacher confidence level	student science learning success	teacher beliefs about science education	NSLP percentage
MEAP	1.00000 57	0.26120 0.0497 57	0.41325 0.0014 57	0.26353 0.0476 57	-0.83899 <.0001 57
teacher confidence level	0.26120 0.0497 57	1.00000 57	0.85150 <0.0001 57	0.19006 0.1567 57	-0.13828 0.3050 57
student science learning success	0.41325 0.0014 57	0.85150 <.0001 57	1.00000 57	0.23316 0.0809 57	-0.19916 0.1375 57
teacher beliefs about science education	0.26353 0.0476 57	0.19006 0.1567 57	0.23316 0.0809 57	1.00000 57	-0.11633 0.3888 57
NSLP percentage	0.83899 <.0001 57	-0.13828 0.3050 57	-0.19916 0.1375 57	-0.11633 0.3888 57	1.00000 57

Key for each grouping of numbers: Top number - Pearson Product-Moment Correlation Coefficients, Middle number - p value, and Bottom number – n.

Figure 2. Pearson Product-Moment Correlation Coefficients for the significant independent variables in this study.

An example of reading the results of Figure 2 is as follows: To find the significance of the correlation between the MEAP and teacher confidence level, go to the MEAP heading across the top of Figure 2 and then look down to the teacher confidence level row and you will see a correlation coefficient of 0.26120 that reflects a very strong

significance between these two variables at a p value of 0.0497. This may be done with the remaining variables as well.

Based upon the results of my Pearson product-moment correlation, I decided to use teacher confidence level ($p = 0.0497$), student science learning success ($p = 0.0014$), teacher beliefs about science education ($p = .0476$), and NSLP percentage ($p = <.0001$). Also, I am including student science learning success ($p = 0.0014$) in the model, rather than value of science kits ($p = 0.0010$) because the survey questions in both are essentially the same, with the one exception of survey question (li), which asks about the teacher's ability to maintain student interest while doing the experiments. They also have a Pearson Correlation Coefficient of .9942 which also indicates that both items are asking the same questions and one should be removed as recommended by Pallant (2013) who stated, "You probably don't want to include two variables with a bivariate correlation of .7 or more in the same analysis" (p. 164). Value of science kits and student science learning success have a bivariate correlation of .9942, so value of science kits was removed from the model. Therefore, because of these values that I had examined with a Cronbach's alpha test and a Pearson product-moment correlation test, there was only four independent values analyzed in my regression analysis, rather than the 11 initially proposed.

In order to determine what effect these four independent variables have on the dependent variable (MEAP), I performed a multiple regression on these values. Prior to performing the multiple regression, I addressed the assumptions for a multiple regression.

Multiple Regression Assumptions

They are: sample size, which was arguably sufficient as shown by my recalculations previously reported in this Chapter IV; independence; normality; homoscedasticity; and linearity. All of the requirements for these assumptions have been met. Since the MEAP scores as reported by schools that have their own teachers and students, they are totally independent of each other and therefore the assumption for independence was met. The assumptions for normality, homoscedasticity, and linearity were also met and can be seen in the subsequent respective Figure 3, Figure 4 and Figure 5.

To address the remaining assumptions for a multiple regressions, please examine the Figures 3 – 5. Figure 3 shows the normality of the residuals with a fairly normal curve for the standardized residual data (data points that do not fall directly on the best fit lines).

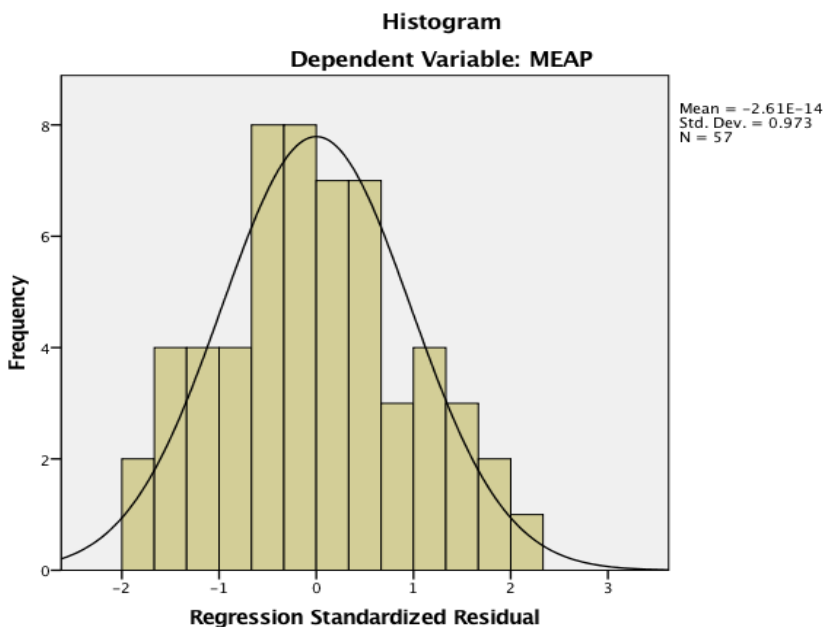


Figure 3. Histogram of the multiple regression's standardized residual data.

Homoscedasticity analysis can be done by looking at Figure 4 and noticing that the data points are equally distributed around the zero points on both axes, they have no definite pattern, and they are mostly located between -2 and +2 on both axes with only two outliers. These qualities meet the recommendations of Pallant (2013).

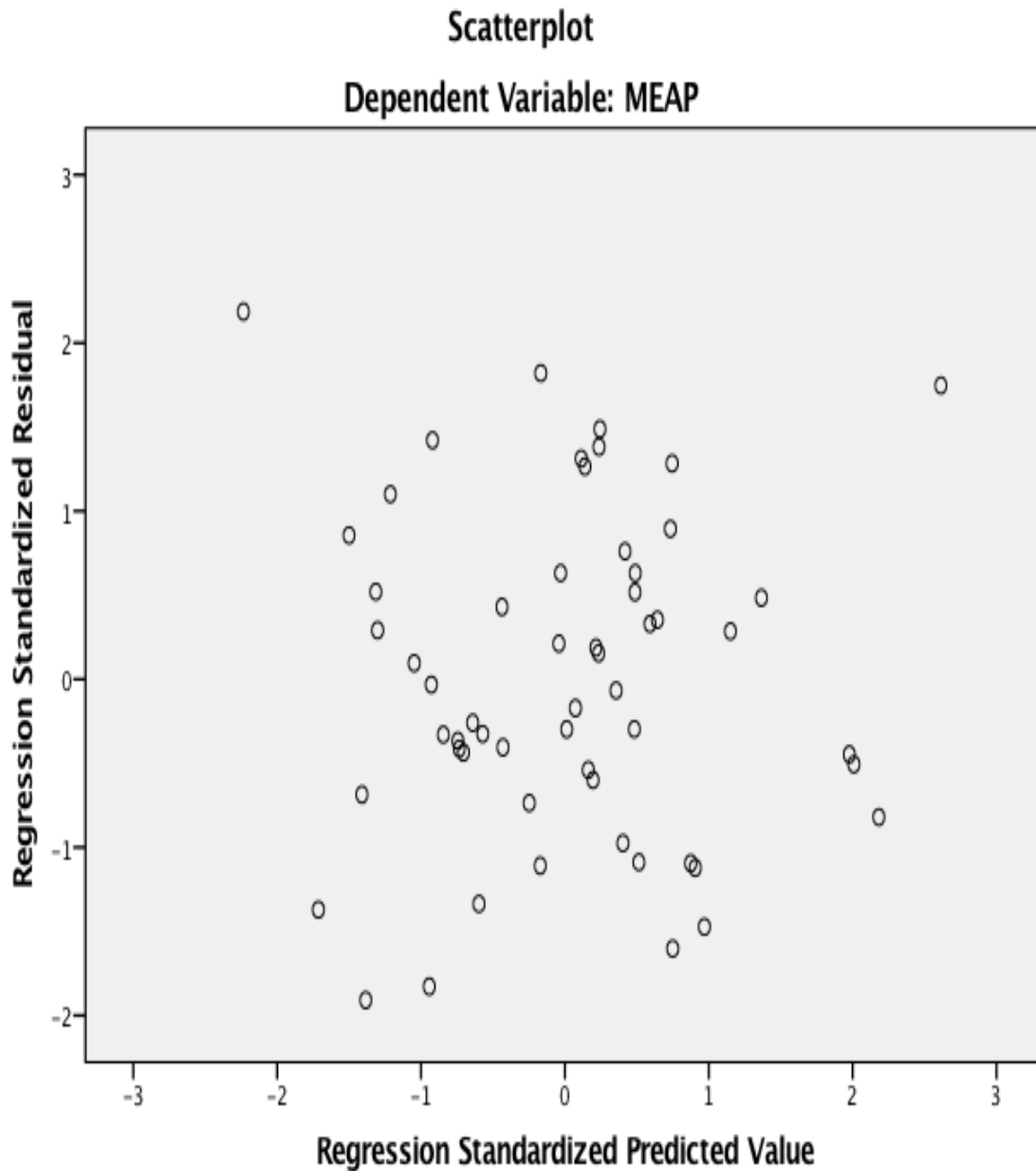


Figure 4. Scatter plot of the multiple regression's standardized residual values.

Linearity of the data can be evaluated by looking at Figure 5. Figure 5 shows that the residual data has a straight-line relationship with the predicted dependent variable as suggested by Pallant (2013).

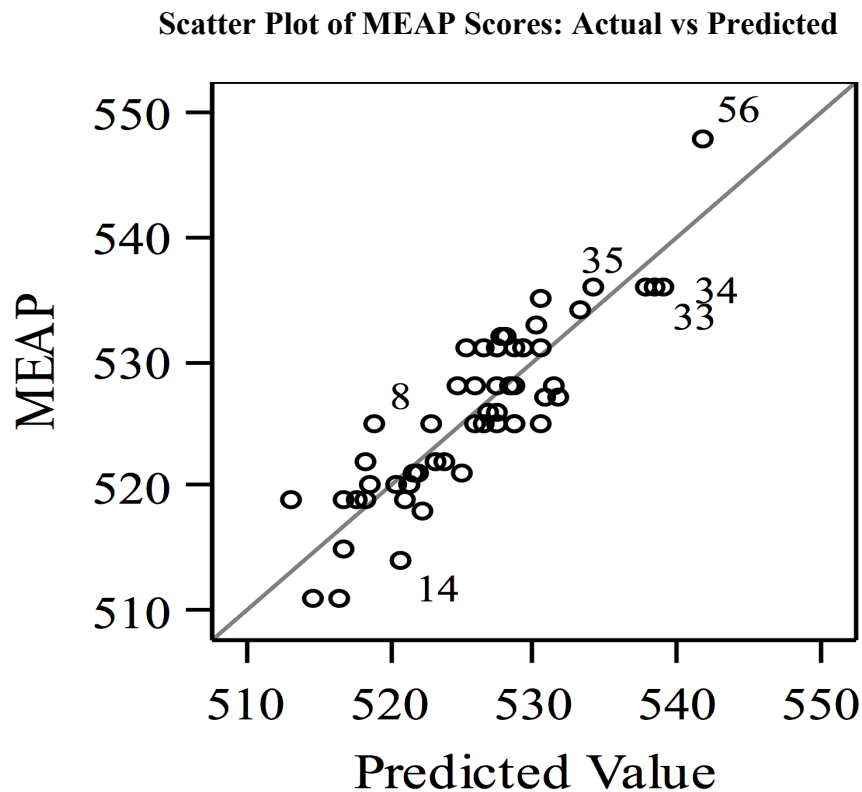


Figure 5. Actual MEAP scores versus the predicted values.

Table 17 shows the results of my regression analysis. Within this table, you can see that two coefficients are positive, suggesting it adds positivity to the model, while two are negative, suggesting that they add a negative effect to the model. When holding the other variables constant, the first coefficient of -2.839 means that for every increase of one unit for the teacher confidence level, the average change in the MEAP score will go down by 2.839 units. The second item, perceived success of learning outcomes has a coefficient of 4.481 which means that for every one unit of increase for this variable, the

average change in the MEAP score will increase by 4.481 units. The third item, beliefs about teaching science in elementary school, has a coefficient of 1.732 which means that for every one unit of increase for this variable, the average MEAP score will increase by 1.732. And lastly, the fourth item, NSLP percentage has a coefficient of -0.290 which means that for every one unit of increase for this variable, the average MEAP score will decrease by 0.290 units.

The R-Squared value of 0.796 shows the amount of variance in the dependent variable accounted for by these independent variables in this model is 79.6%, and is acceptable because the value is between .6 and .9 as recommended by Rabayah (2014).

Table 17

Regression Analysis: Teacher perceptions of Science Kit Usage and their Relationship to their 5th Grade State Science Exam

	Unstandardized Coefficients	Standard Error	p - value
Intercept	534.047	6.024	<.001
teacher confidence levels	-2.839	1.426	0.0517
perceived success in learning outcomes	4.481	1.256	0.0008
beliefs about teaching science in elementary school	1.732	0.951	0.0755
NSLP percentages	-0.290	0.024	<.0001
		R-Squared	
		0.796	0.001

In analyzing the unstandardized coefficients, the values seem to reflect what anyone in education would expect with the exception of one. It makes sense to me that as the “perceived success in learning outcomes” increases, the MEAP scores would increase as well. It also makes sense to me that as the “beliefs about teaching science in elementary school” increase, the MEAP scores would increase as well. And lastly, it makes sense to me that as the NSLP increases for a school, the MEAP scores would

decrease. The one finding that does not make sense to me is the one that reflects a negative value for “teacher confidence levels” that means, as the “teacher confidence levels” increase, the MEAP scores will decrease. This result needed further investigation and the analysis of this apparent anomaly in the data is explained here.

When calculating and analyzing the unstandardized coefficients, one must remember that they are marginal. So in analyzing the variable “teacher confidence levels,” the term marginal means that if all of the other independent variables in the multiple regressions equation are held constant, this is what the variable “teacher confidence levels” would do to the MEAP score if it were to increase by 1 unit. So if you look at a plot of just the dependent variable, MEAP score, versus the independent variable, “teacher confidence levels” in Figure 5, there is a positive relationship, though not a strong one, between the dependent variable and the independent variable.

That low positive relationship for “teacher confidence levels” can be seen in Figure 5 by its flatness reflecting a slope nearly approaching zero. But when you add the other variables, the coefficient value for “teacher confidence levels” becomes negative. The reason for that is because the variables “teacher confidence levels” and “student science learning success” have a very highly positive correlation, as seen in the Pearson Product-Moment Correlation Coefficients, Figure 2. But when you insert the variable coefficient of 4.48 for “student science learning success,” into the multiple regression equation, the variable coefficient for “teacher confidence levels” of 1.45 (when it was the only independent variable analyzed against the dependent variable), becomes -2.84 . This happens for two reasons. First Figure 6 shows a very low slope for the “teacher confidence levels” which nearly approaches zero, or the negative range. And secondly,

with the coefficient for the variable for “student science learning success” being the larger of the two, its effect when entering it into the multiple regression equation drives the slope for “teacher confidence levels,” which was essentially zero, into the negative portion of the graph. Once this is understood, one can see that even though the coefficient for “teacher confidence levels” is reflected as negative in Table 17, in reality, when the variable “student science learning success” goes up, the variable “teacher confidence level” will go up as well because of the very highly positive Pearson Product-Moment Correlation Coefficients with a significance of $p < .0001$. This is considered statistically, “a dampening effect” that the variable “student science learning success” has upon the variable “teacher confidence levels” (C. Kinkaid, personal communication, May 18, 2016). So now, after one understands this “dampening effect,” it should make sense that as “teacher confidence levels” go up, the MEAP scores are predicted to go up as well.

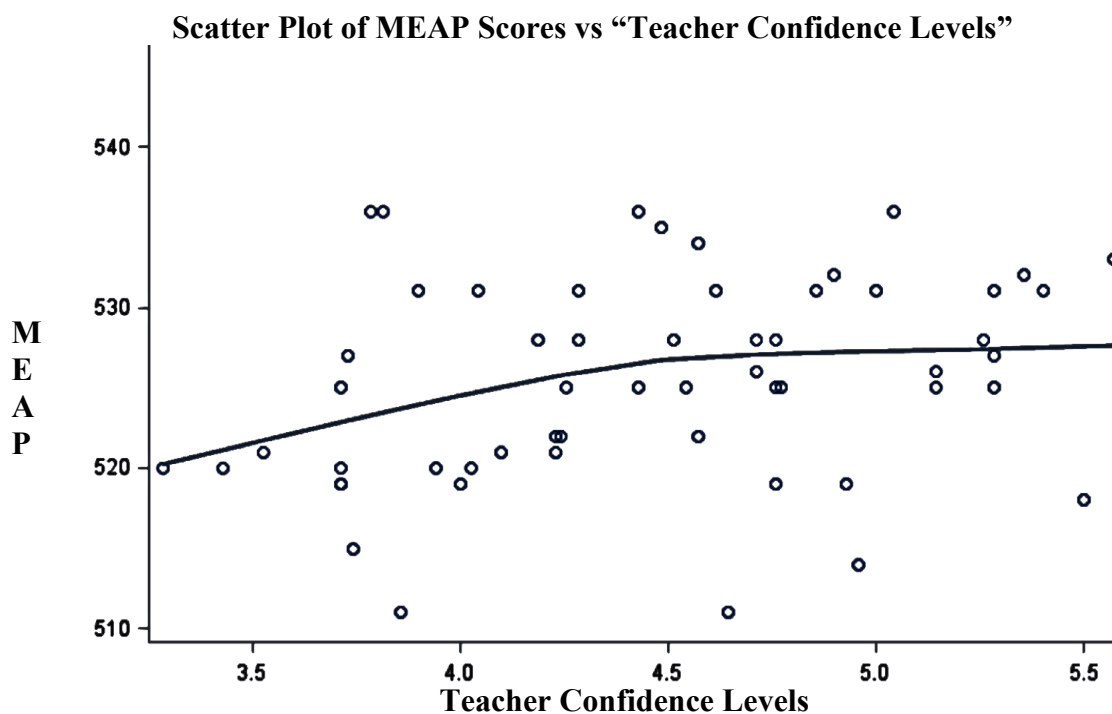


Figure 6. MEAP scores versus the variable, “Teacher Confidence Levels.”

Another way of explaining this “dampening effect” is to perform a multiple regression on the variable for teacher confidence levels, 1c by itself, and the MEAP and to the other variables both individually and in all possible combinations. Figure 7 shows these regression results. When you only regress 1c and the MEAP, you get a positive 3.192 coefficient. When you regress 1c, 1f, and the MEAP, you get that negative coefficient value that is of concern (- 3.050). This result generated the question being address here as to when a teachers’ confidence in teaching elementary school science increases, the MEAP scores decrease. When you regress 1c, 1g, and the MEAP, you get a positive 2.681 coefficient. When you regress 1c, % NSLP, and the MEAP, you get positive 1.287. When you regress 1c, 1g, and % NSLP, and the MEAP, you get a positive coefficient value of 1.099. And lastly, when your regress all of the variables, you get the negative value for 1c (- 2.839).

So once the Figure 7 is examined, one can see that you only get a negative value for variable 1c (teacher confidence levels) when the variable 1f (perceived success in learning outcomes) is included in the regression. As pointed out before, the independent variable 1c has no significant correlation to any other independent variable with the exception of 1f. As seen in Figure 2, the Significant Pearson Product-Moment Correlation Coefficients, one can see that 1c and 1f have a very high correlation level of $p < .0001$. Because of this very high correlation between these two independent variables, one can say that as 1f goes up, 1c will go up as well even though the Unstandardized Coefficient for the independent variable is reflected as a negative value.

	Unstandardized Coefficients	P values
Multiple Regression Variables		
MEAP vs 1c (teacher confidence levels)	3.192	p = .054
MEAP vs 1c (teacher confidence levels)	- 3.050	p = .226
and		
1f (perceived success in learning outcomes)	6.673	p = .003
MEAP vs 1c (teacher confidence levels)	2.681	p = .093
and		
1g (beliefs about teaching science in elementary school)	4.969	p = .022
MEAP vs 1c (teacher confidence levels)	1.287	p = 1.287
and		
% NSLP (% National School Lunch Program)	-0.310	p = 0.000
MEAP vs 1c (teacher confidence levels)	1.099	p = 0.226
and		
1g (beliefs about teaching science in elementary school)	2.472	p = 0.045
and		
% NSLP (% National School Lunch Program)	-0.299	p = 0.000
MEAP vs 1c (teacher confidence levels)	-2.839	p = 0.044
and		
1f (perceived success in learning outcomes)	4.481	p = 0.001
and		
1g (beliefs about teaching science in elementary school)	1.732	p = 0.006
and		
% NSLP (% National School Lunch Program)	- 0.290	p = 0.000

Figure 7. Differences in unstandardized coefficients depending upon which independent variables are included in the multiple regression.

When discussing the four independent variables, it is necessary to address the exclusion of one research variable that people would think should definitely be in the multiple regressions equation. That independent variable is 1a: levels of science kit usage, including the inquiry-based experiments, assessments and science reading, writing and journaling activities. Since this entire research project centers around the perceptions of the teachers teaching elementary school science and using the science kits as a resource, an argument could easily be made for its inclusion. Statistically speaking, one can see why the four independent variables, 1c, 1f, 1g and % usage for NSLP were included in the multiple regression equation (essentially because of their high to very high significance to the dependent variable, the MEAP score, $p = 0.0497$, $p = 0.0014$, $p = 0.0476$ and $p < .0001$ respectively). But, the independent variable 1a did not have a significant correlation to the MEAP because it had a p value of 0.2672.

To understand why the independent variable 1a was excluded, one must understand the following. Even though 1a does not have any significant correlation with the MEAP, it does have a significantly high correlation to the other variables, 1b, 1c, 1d, 1e, 1f, and 1g. And when plotting the MEAP scores versus 1a, there is a positive slope, yet small, as seen in Figure 8. There also appears to be some influential observations that jump out at you, namely #14, #27, #33, #35, and #56, because they do not closely match the other data points. These points are also identified in the “Studentized Residuals and Cook’s D for MEAP” Table 18 as points of interest that possibly should be deleted. The rule of thumb is that if you take 4 and divided it by the number of respondents, 57, you will get a value which indicates the cutoff point for responses that should be eliminated (C. Kinkaid, personal communication, June 23, 2016). This would give you: $4/57 =$

0.0702. So any responses that have a Cook's D value larger than 0.0702, namely #14, #27, #33, #35 and #56 were deleted.

Scatter Plot of MEAP vs "1a – Kit Usage"

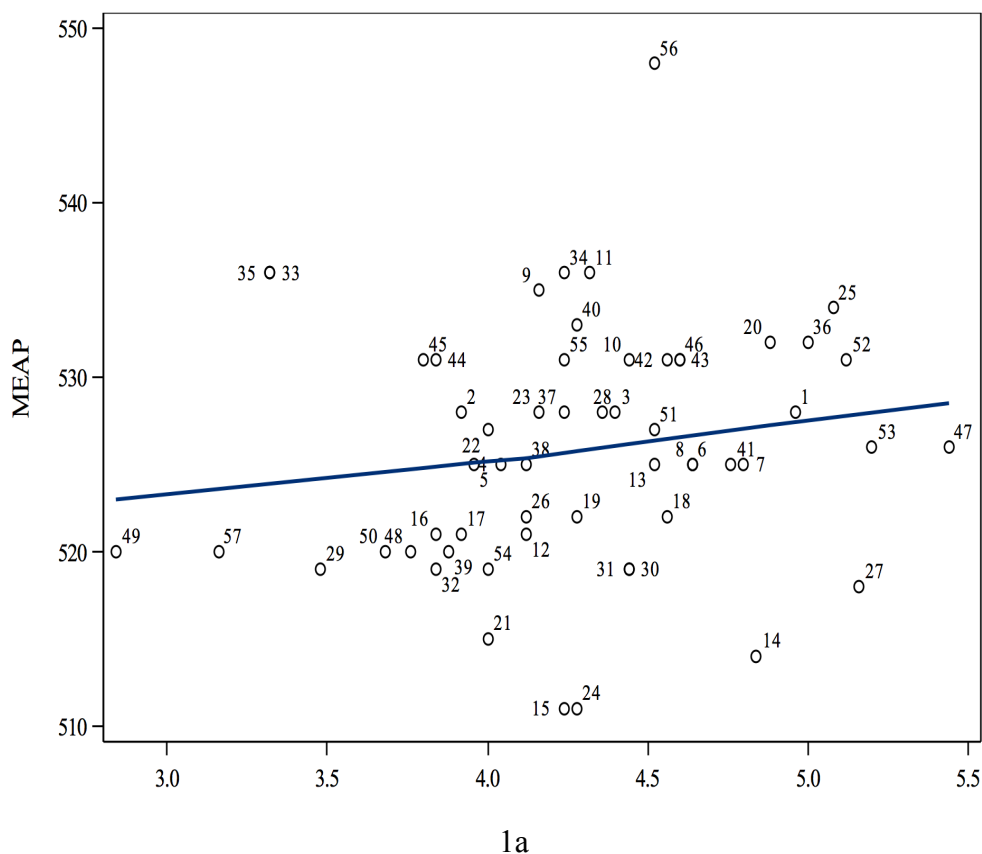
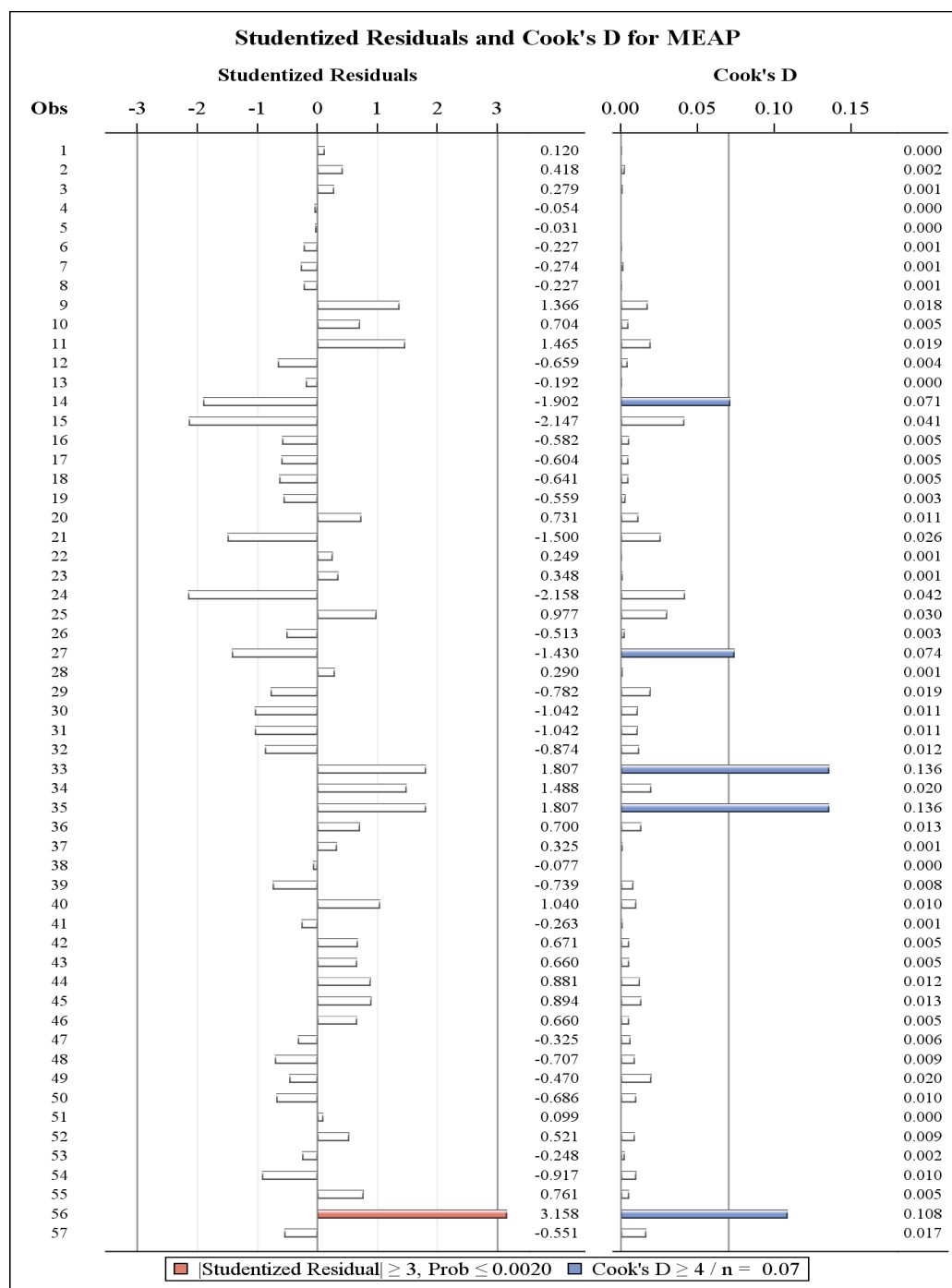


Figure 8. MEAP scores versus the independent variable 1a – “Kit Usage.”

After graphing MEAP versus 1a, a regression analysis was performed comparing the MEAP scores to the independent variable 1a. The slope was not statistically significant ($p = 0.2672$), but as the Cook's D and the Studentized Residuals Table 18 showed, there were some influential observations. The top five influential observations, #14, #27, #33, #35, and #56 were removed and a new plot was created, Figure 9.

Table 18

Studentized Residuals and Cook's D for MEAP

Scatter Plot of MEAP vs “1a – Kit Usage” minus 5 Influential Observations

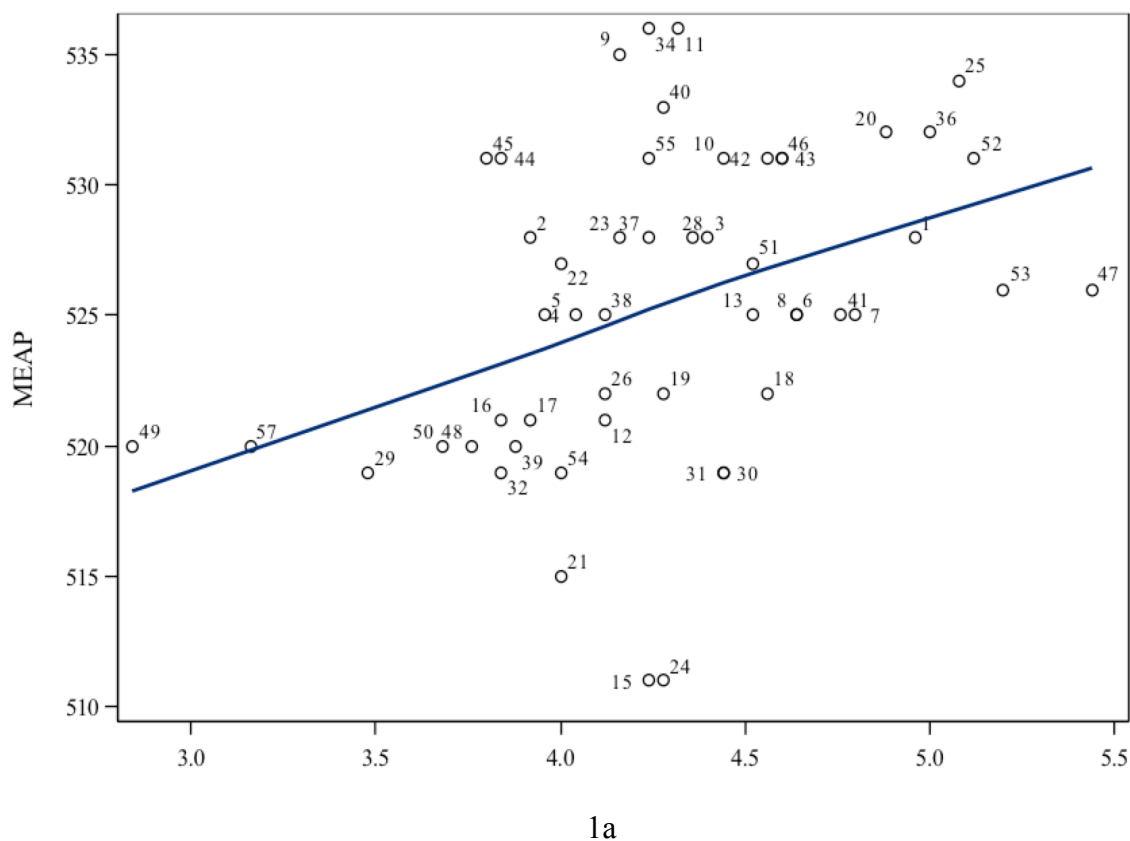


Figure 9. Plot of MEAP vs “1a – Kit Usage” minus 5 influential observations.

This slope is much steeper than the plot including the 5 influential observations and gives us an estimate slope value of 4.657 ($p = 0.0044$). However the R^2 is only 0.1512, so it does not contribute much to the variance explanation of the MEAP scores.

Now I performed a new regression equation including the variable 1a along with the already included 1c, 1f, 1g and % usage for NSLP variables. This calculation showed all the variables as significant except, again, for 1a. Variable 1c is marginally significant, but worth keeping.

There is clearly a relationship between the MEAP and variable 1a, but it's not a strong enough relationship to be included when the other variables are already in the model.

Predicting MEAP Scores

With these coefficients being determined and the assumptions for a multiple regression being satisfied, I can now write the multiple regression equation that could be used by individual schools to predict their MEAP scores after inserting their own survey input into the equation. The equation is as follows:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \hat{\beta}_3 x_3 + \hat{\beta}_4 x_4$$

where \hat{y} is the estimated dependent value, $\hat{\beta}_0$ is the estimated y-intercept, $\hat{\beta}_1$ is the estimated coefficient for x_1 (teacher confidence), $\hat{\beta}_2$ is the estimated coefficient for independent variable x_2 (success of learning outcomes), $\hat{\beta}_3$ is the estimated coefficient for x_3 (beliefs about teaching science in elementary school) and $\hat{\beta}_4$ is the estimated coefficient for x_4 (% usage of NSLP).

Therefore, if low scoring schools could increase their values for the first three independent variables, teacher confidence level, student science learning success, and teacher beliefs about science education, there is a significant chance that this will result in higher MEAP science scores. The only independent variable that can not really be changed to any appreciable amount is the percentage of students participating in the National School Lunch Program.

Chapter IV Summary

The materials found in Chapter IV are the findings related to the perceptions offered by the kit using teachers in this study. It started with basic descriptive statistics,

followed by the inferential statistics and lastly, the multiple regression equation that reveals which variables can be used to predict MEAP outcomes. In Chapter V, a detailed discussion is presented including the findings of this study, their relationship to previous research on this topic, and suggestions for future research in the area of elementary school science education. The final section found in Chapter V includes suggestions to school administrators on how they can take the data collected in this study and determine what components of the kit program they could address in order to obtain better MEAP scores for their respective schools.

CHAPTER V

DISCUSSION

In chapter II, I examined the present knowledge concerning the multiple efforts and suggestions to make teaching elementary school science more comfortable and productive for all involved. Specifically the research centered around modifying pre-teacher undergraduate programs, increasing pre-service teachers' science knowledge, decreasing the roadblocks to implementing good science education, and the use of inquiry-based science teaching with the use of science kit programs.

Prior to my study, some researchers like Ucar and Sanalan (2011) believed the best way to facilitate more elementary school student science learning was by altering teachers' pre-service programs. Dobey and Schafer (1984) found that many classes in elementary school were being taught by inexperienced teachers with weak backgrounds in the sciences, and therefore had a poor sense of self-efficacy related to their abilities to teach science subjects. Further, even though the fact that science had been generally accepted across the country as a subject that should be included in all elementary school curricula, Lee and Houseal (2003) addressed how this could possibly be done in an already full curriculum that each elementary school teacher encounters on a daily basis. Other researchers like Rennie et al. (2010) professed that the best elementary school science teaching could take place with inquiry-based science being taught by use of science kits.

Therefore, my study, by use of a researcher created survey, sought the perceptions of these aforementioned issues along with teacher and school demographics. It specifically, quarried these issues with teachers who are presently using, or have used, a

science kit program and provided information to answer research question 1. The results of research question 1 were used to answer research question 2. The survey questions were collapsed into new coded independent variables which were used to develop a multiple regression equation. This equation reflected which independent variables that had a significant effect on the dependent variable (the state's 5th grade science exam). By use of this equation, schools could plug in their respective data they submitted in the survey and find out what areas of the science program needed attention in order to increase their state test scores.

The survey was divided into eleven parts. They included reactions to: (a) Kit Usage, (b) District Provisions, (c) Principal Provisions, (d) Regional Math and Science Provisions, (e) Professional Development, (f) Consistent Use of Kit Contents, (g) Value of Kit Content, (h) Formative and Summative Assessments, (i) Use of Student Journals, (j) Consistent Growth of Kit Usage, and (k) Science Teaching Time.

Summary of Major Results by Research Question

The findings presented here are the result of the analysis of 245 completed K-6 teacher surveys from 57 schools in a Midwestern state. In order to better understand each teacher's situation, several demographic questions were also included in the survey. The demographic questions were: major/minor in science, years of teaching, years of using science kits, percentage of students eligible for the Federal School Lunch program, teacher gender, grades presently teaching, and grades taught in the past (as seen in Table 2 of Chapter IV). The last three were not used in the study, but collected for use by the regional math and science center.

The teachers who responded to the survey were fairly well distributed between Kindergarten and 5th grade, while 6th grade had only 16 respondents. The gender distribution was 13% male and 87% female. The years of teaching ranged from 1 to 30, with an average of 14.5. The years of using the kits ranged from 1 to 24, with an average of 8.2. The percentage of students eligible for the Federal School Lunch Program had a range from 4% to 92%, with an average of 52%.

This section displays the major findings for my two research questions. A summary of these key findings is displayed in Table 21 at the end of this section.

Research Question 1

Research question 1 asked: For teachers presently using or have used the “Science Unit Kit Program” in elementary schools which have fully adopted a science kit program (i.e., kits available for all teachers in grades K-5), what are their perceptions regarding: (a) levels of science kit usage, including the inquiry-based experiments, assessments and associated science reading, writing and journaling activities; (b) perceived value of aspects of the science kits in helping students learn science concepts; (c) their confidence levels in teaching elementary school science using the kits as a resource; (d) support levels from the school, district and regional math and science center; (e) quality of professional development from the kit designers; (f) any success related to science student learning outcomes; and (g) beliefs regarding the teaching of science in elementary school?

Kit usage and related issues. Research question 1a dealt with the levels of science kit usage, including the inquiry-based experiments, assessments and associated science reading, writing and journaling activities. The participating teachers responded at

a rate of 69% of “agree” or “strongly agree” that their students loved doing the experiments contained in the kits. The participating teachers responded at a rate of 46% of “agree” or “strongly agree” that the reading and writing materials for the kits were grade level appropriate. The percentage of teachers responding to how much time has been devoted to using various contents of the kits with a “most of the time” or “always” was 67% for experiments, 55% for formative assessments, 66% for summative assessments, 37% for recommended pre-reading time, 30% for pre-writing time, 50% for recommended reading integration-time, 24% for industrial journals, and 74% for student journals. The percentage of teachers responding with a “significant value” or “very valuable” for such items was 73% for experiments, 42% for formative assessments, 39% for summative assessments, 31% for recommended pre-reading time, 32% for recommended pre-writing time, 49% for recommended reading integration-time, 18% for industrial journals, and 62% for student journals. The percentage of teachers responding with an “agree” or “strongly agree” was 56% for a very close relationship between the assessments and the students’ understanding, 61% for the assessments matching the material covered in the unit, and 63% for a strong expectation for the teachers to use them. In reference to the use of the student journals contained in the kits, the percentage of teachers responding with an “agree” or “strongly agree” was 59% for most students completing the journals, 36% for quality work in the journals, and 58% for a strong expectation for the teachers to use the journals. Regarding consistent growth of kit implementation observed by the experienced teachers, the percentage of these teachers responding with an “agree” or “strongly agree” was 38%.

There were other interesting responses that dealt with kit usage, but not specifically research question 1a as explained here. Sub-questions concerning students experiencing great success showed that 49% answered this question with an “agree” or “strongly agree” response, while consistent growth in understanding showed a 50% response of “agree” or “strongly agree,” and growth in student excitement showed a 59% response of “agree” or “strongly agree.” The responses for teacher confidence in teaching science reflected an “agree” or “strongly agree” rate of 75% while, being better at teaching science was 66%, ease of writing lesson plans was 63%, completing lessons was 26%, maintaining student interest was 43%, and enjoyable teaching experience was 52% for responding “agree” or “strongly agree” to these questions. For sufficient amount of kit materials and monitoring of the kit program, 74% and 22% respectively responded with “agree” or “strongly agree.” The responses for the importance of having a strong science program and integrating literacy and math into the science lessons received responses of “agree” or “strongly agree” at the rate of 89% and 87% respectively. With using the rating scale of “most of the time” or “always” for the teacher responses, inquiry-based experiment usage was 67%, formative assessment usage was 55%, summative assessment usage was 66%, recommended pre-reading time usage was 37%, recommended pre-writing time usage was 30%, recommended reading integration-time usage was 50%, industrial journal usage was 24% and student journal usage was 74%. When addressing the items concerning formative and summative assessments and using the rating scale of “agree” or “strongly agree,” there appears to be a fairly close rating range of 56% to 63% for the following question components: students’ understanding was 56%, the assessment match closely to the material being taught was 61% and a

strong expectation to use them was 63%. Using the rating scale of “agree” or “strongly agree” for journal use, the items stating that most of the students complete them was 59%, that most students enter quality work was 36%, and that there is a strong expectation to use them was 58%.

Value of science kits. Research question 1b deals with the perceived value of aspects of the science kits in helping students learn science concepts. In reference to student success in meeting the student outcomes for science, the participating teachers responded at the rate of 49% for “agree” or “strongly agree” that the students were having great success in meeting these outcomes, and 50% “agree” or “strongly agree” that their students are having consistent growth in understanding science concepts. Close to 60% of the teachers noted student excitement about learning science. These questions were also asked only to the experienced teachers who had been at their present school for 3 years or more, and their responses were lower for understanding at 38% and the essentially the same at 52% for student excitement in learning science.

There appears to be about half of the teachers who felt that their students were doing well at understanding science concepts and a larger percentage of students were showing considerable excitement in learning science. From the responses from the experienced teachers, there appeared to be minimal growth in the kit program used in the represented schools.

There were other interesting responses that dealt with kit usage, but not specifically research question 1b as explained here. Using the rating scale of “significant value” or “very valuable” for the teacher responses, the rating for inquiry-based experiments was 73%, for formative assessment it was 42%, for summative assessment it

was 39%, for recommended pre-reading time it was 31%, for recommended pre-writing time it was 32%, for recommended reading integration-time it was 49%, for industrial journals it was 18%, and for student journals it was 62%. For teachers who have been at their school for three years or more years (86%), the responses with a scale of “agree” or “strongly agree” for kit implementation was 38%, for support for the program it was 36%, for student understanding it was 38%, for student excitement it was 52%, and for teacher self-confidence it was 45%. And lastly, when addressing time to teach science and using a rating scale of “increased some” or “increased a great deal,” a rating of 19% was recorded.

Overall the use of the kits was quite positive and the use of most of the items contained in them was positive as well. Some of the less positive comments concerned the use of the student journals and kit assessments. The use of student journals was rated the highest in usage and second in value behind the value of inquiry-based experiments. For inquiry-based experiments, the rating for value was a little higher than for usage. The rating for summative assessments was pretty high for usage and pretty low for value. The rating for formative assessments was less for usage than the rating for the summative assessment usage but a little higher in value. The rating for pre-reading time was a little higher in usage as compared to its value. The recommended reading integration time was essentially the same for usage and value as was the results for pre-writing time. The rating for industrial journals was the lowest for both usage and value, which makes sense in that, if it was considered a little value, it would be used the least amount of time in the classroom. Table 19 shows these comparisons.

Table 19

Comparison of “Kit Content use” to “Kit Content Value” (n=245)

<i>Sum by percentage of</i>	<u>Kit Content Usage</u>	<u>Kit Content Value</u>
	“Always” and “Most of the Time” %	“Very Valuable” and “Significant Value” %
student journals	76.8	61.2
inquiry-based experiments	66.5	72.8
summative assessments	66.1	39.1
formative assessments	55.4	41.5
recommended reading integration time	49.4	48.7
recommended pre-reading time	37.5	31.3
recommended pre-writing time	30.7	31.8
industrial journals	24.1	17.8

Note: Not all respondents responded to all items.

In analyzing these responses for research question 1a, several trends are noticeable. It appears that the students enjoy doing the kit experiments, 66.5 responding “agree” or “strongly agree,” and the teachers find them very valuable in teaching their science lessons, 72.8 responding at “significant value” or “very valuable.” The use of the formative and summative assessment are used over 50% of the time, but are considered of value below a 50% level. Pre-reading and pre-writing times were in the 30% to 40% range and their value was assessed in the low 30% range. The use and value of integration-time was right at the 50% level of response. The use and value of industrial journals received the lowest rating 24.1 and 17.8 respectively. The use and value of the student journals received the highest ratings, but the quality of the students’ entries was

not considered to be quality work. Therefore, it appears that both the students and teachers liked doing the kit experiments and using the student journals for recording and discussing their results. After looking at the open-ended responses, these ratings for the assessments appear to reflect what the teachers feel about adding additional time for testing along with their already implemented ways of assessing student progress. The expectation to use the journals was not significantly high at 58%. The last part of this research question reflects that seasoned teachers do not see much growth of the kit program within their schools and responded with only a 38% positivity rating.

Teacher confidence level. Research question 1c dealt with the confidence level of the elementary school teachers in teaching science in their classrooms, and 75% of the teachers “agree” or “strongly agree” to expressing their confidence level in teaching science. The participating teachers reported a positive response of “agree” or “strongly agree” to the query of their abilities to better teach science at a rate of 66%. The remaining responses for this research question also address the categories of “agree” or “strongly agree,” including ease of writing lesson plans (63%), ease in completing their classroom lessons in the allotted time (63%), maintaining student attention (43%), and enjoyable teaching experience (52%). The experienced teachers, reflected a 45% rating for consistent growth in teacher confidence levels while teaching science with the kits.

These teacher responses suggest that the level of teaching science by using the kits, has provided a significant amount of teacher confidence, as well as their ability to teach science. The teachers reported that over half find teaching science with the kits to be enjoyable, yet maintaining student attention was rated lower and the time allowed to complete the lessons in the allotted class time was very low at 26%.

Support levels. Research question 1d dealt with the perceived support the teachers receive from their respective school districts, principals and the regional math and science center. Related to the amount of materials contained in the kits and if they are sufficient to do the required experiments for the respective lessons, on an “agree” or “strongly agree” rating, the teachers were very positive with their responses with a 74% rating. Over half of the teachers responded positively about the curriculum support they receive from their respective districts, but responded at only a 25% rate when answering the question concerning the district providing additional training for teaching science. Another low area with the response rate of only 22% addressed the monitoring of the kit program.

In reference to the support provided by the school principals and using an “agree” or “strongly agree” rating, these responses were all low, namely; 22% for additional training money, 23% to discuss their science teaching, 27% for principal mentoring, 41% for encouragement for their teaching, and 42% for providing the necessary literacy trade books. In reference to the support provided by the regional math and science center and using an “agree” or “strongly agree” rating, these responses were quite high, with 89% being reported for timely delivery for missing materials, 88% for the initial delivery of the kits, and 86% for timely return of phone calls and text messages. The professional development provided by the regional math and science center received a 56% rating. On the other end of the spectrum were the responses from the experienced teachers about the school’s consistent support for the kit program and the time allotted for teaching science. These questions only received a rating of 38% and 19% respectively.

Overall, the responses to research 1d suggest that the perceived logistical support provided by the regional math and science center was very good. With the exception of providing needed trade books, the variety of support and monitoring provided by the principal was very low. Very poor responses were received from the experienced teachers when addressing their school's consistent support for the kit program.

Teacher confidence levels in teaching elementary school science with the kits were reflected as quite high, along with the enjoyment both the teachers and students received. Support levels from the respective school districts were reported as average, but the provision for money to receive additional science training outside of school was quite low. The ratings for the support levels for principal support were all quite low. The ratings for the support level from the regional math and science center were very high except for the provided professional developments on the kits which were just average. The excellence of the professional developments received the lowest ratings.

Table 20 reflects a comparison of the support the teachers received from the three sources in this study. The highest percentages of "agree" or "strongly agree" were found with the support received from the regional math and science center, but in reality, these should be high for any institution which is working efficiently. The lowest percentages were reported for principal support. This might indicate a dysfunctional system where the school principals should be the person most instrumental in the implementation of the kit program. Student success in using the kits and learning science were reported as just average. The ratings for teachers believing that it is very important to have science included in the elementary school curriculum received a very high rating.

Table 20

Comparison of Support Provided by the School District, the Principal and the Math and Science Center (n=245)

<i>I was provided</i>	<i>Source</i>	<i>Percentage of responses with a “agree” or “strongly agree”</i>
timely delivery of any missing program materials	Math and Science Center	89.1
timely delivery of the science units	Math and Science Center	88.6
timely return of text or phone requests for assistance	Math and Science Center	86.7
quality professional development	Math and Science Center	57.2
a comprehensive science curriculum for me to use with my students	School District	55.1
all needed literacy trade books that go along with the science kits	School Principal	41.6
sufficient encouragement for my science teaching	School Principal	39.8
sufficient mentoring or a mentor for my science teaching	School Principal	27.2
sufficient additional training for teaching science in my classroom beyond the unit kit training	School District	24.3
sufficient time to discuss my science teaching	School Principal	22.6
sufficient money for attending other science training	School Principal	21.5

Note: Not all respondents responded to all items.

Professional development. Research question 1e addressed the professional developments provided by the regional math and science center. With the exception of the excellence of the professional developments (44%), all responses for these survey questions were in the range of a low of 52% for sufficient to meet my needs, to a high of

60% for timeliness of the professional development meetings. The others in this range were supportive of my needs and easy to attend (55% each), and constructed in a way to make the content easily understandable (57%).

These findings suggest that 44% of participating teachers feel that the professional development regarding the science kits were excellent, while roughly 50% to 60% of the remaining components of the professional developments deserved an “agree” or “strongly agree” rating.

Student success. Research question 1f addressed the perceived success found with the students’ science learning outcomes, and in reference to the kits helping the success of the students in meeting student science outcomes, 49% of the teachers responded with an “agree” or “strongly agree,” consistent growth in student understanding was reported with a 50% rate, student excitement while using the kits received a teacher rating of 59%, and the ability of the teacher to maintain student attention, received a 43% rate response. The experienced teachers responded with a ratings of 38% for consistent growth in student understanding, and 52% for consistent student excitement about science.

The findings for this research question suggest that the students maintain their excitement about using the kits, but the teachers have some difficulty in maintaining student attention during these lessons. Approximately 50% of the teachers felt that the students were obtaining sufficient science understanding, while the experienced teachers reported lower percentages for consistent student understanding, but a little higher response rate for student excitement.

Beliefs about science. Research question 1g addressed the teachers' beliefs about the teaching of science in elementary school, and 89% of the teachers gave a very positive response for having a strong science program in elementary school and 87% of the teachers gave a very positive response for integrating literacy in math and science lessons. These responses suggest that the elementary school teachers very much appreciate the need for a strong science program and for the integration of science into other subject areas, but after summarizing the responses to the other survey questions, they felt frustrated in many ways while trying to bring their beliefs to fruition.

Table 21 shows the major findings associated with the seven sub-portions of research question 1 (1a thru 1g).

Table 21

Research Question 1 Major Findings

Question	Major Findings
For the kit using teachers, what are their perceptions regarding levels of science kit usage, including the inquiry-based experiments?	<ul style="list-style-type: none"> (a) The teachers believe that students love doing the science experiments contained in the kits and are considered very valuable to the program. Mean: 4.83 out of 6. (b) Less than half the teachers felt that the reading and writing materials were at grade level. Mean: 3.13 out of 6. (c) The teachers were not strongly interested in using the assessments included in the kits because of either the time restraints or the use of their own assessments. Formative – Mean: 4.07 out of 6. Summative – Mean: 3.93 out of 6. (d) Pre-reading and pre-writing times were also not well received by the teachers. Pre-reading – Mean: 3.81 out of 6. Pre-writing – Mean: 3.75 out of 6. (e) Over half of the teachers liked using the student journals, but very few were interested in using the industrial journals. Student journals – Mean: 4.63 out of 6. Industrial journals – Mean: 2.86 out of 6. (f) Over half the teachers felt that there were strong expectations for them to use the student journals. Mean: 4.41 out of 6. (g) The experienced teachers did not see any significant consistent growth of their kit program in their respective schools. Mean: 3.69 out of 6.

Table 21 – continued

Question	Major Findings
For the kit using teachers, what are their perceptions regarding the value of aspects of the science kit program in helping students learn science concepts?	<ul style="list-style-type: none"> (a) Approximately half of the teachers felt that their students were having great success in meeting their science outcomes. Mean: 4.26 out of 6. (b) Approximately half of the teachers felt that their students were showing consistent growth in understanding science concepts. Mean: 4.30 out of 6. (c) Excitement about learning science had a more favorable rating than the above ones (a and b). Mean: 4.56 out of 6. (d) The experienced teachers felt that the understanding was lower than what the other teachers reported, but the student excitement was about the same. Understanding – Mean: 3.83 out of 6. Student excitement – Mean: 4.08 out of 6.
For the kit using teachers, what are their perceptions regarding the confidence levels in teaching elementary school science using the kits as a resource?	<ul style="list-style-type: none"> (a) The increase in confidence levels, while teaching elementary school science, was high. Mean: 4.82 out of 6. (b) The teachers' feelings about their abilities to better teach science was high as well. Mean: 4.68 out of 6. (c) A little over half of the teachers' ability to write lesson plans and the findings concerning the enjoyment of teaching science were reported as favorable. Writing lesson plans – Mean: 4.53 out of 6. Teaching enjoyment – Mean: 4.36 out of 6. (d) The teachers' responses to the fact that they have sufficient time to teach their lessons were very low. Mean: 3.49 out of 6.
For the kit using teachers, what are their perceptions regarding the support levels from the school, the district and the regional math and science center?	<ul style="list-style-type: none"> (a) The teachers reported that the support from their school district was sufficient in respect to science curriculum, but very poor for obtaining the resources for further education on teaching science. Science curriculum – Mean: 4.32 out of 6. Obtaining resources – Mean: 3.19 out of 6. (b) The teachers reported that the support they receive from their respective principals was low to very low. Mean: 3.28 out of 6. (c) The logistics involved with the kits was rated as very good. Mean: 4.73 out of 6. (d) The quality of the professional developments was reported as just satisfactory. Mean: 4.14 out of 6. (e) Time to teach science and consistent support for the kit program was rated as very poor to poor by the experienced teachers. Time – Mean: 2.80 out of 6. Support – Mean: 3.69 out of 6.

Table 21 – continued

Question	Major Findings
For the kit using teachers, what are their perceptions regarding the quality of the professional development from the kit designers?	<p>(a) The timeliness of the professional developments and ease of understanding received the highest ratings, while only half of the teachers felt that they were excellent meetings. Timeliness – Mean: 4.50 out of 6. Ease of understanding – Mean: 4.36 out of 6. Excellence – Mean: 4.15 out of 6.</p> <p>(b) About half of the teachers felt that the professional developments were sufficient to meet their needs. Mean: 4.24 out of 6</p>
For the kit using teachers, what are their perceptions regarding any success related to science student learning outcomes?	<p>(a) Approximately half of the teachers felt that their students were meeting their science outcomes and were demonstrating student science understanding. Outcomes – Mean: 4.26 out of 6. Understanding – Mean: 4.30 out of 6.</p> <p>(b) The student excitement about doing science was once again reported by the teachers as good. Mean: 4.56 out of 6.</p> <p>(c) The experienced teachers reported a poor result in consistent growth in the students showing understanding and students meeting their science outcomes. Understanding – Mean: 3.83 out of 6. Meeting science outcomes – Mean: 4.26 out of 6.</p>
For the kit using teachers, what are their perceptions of their beliefs regarding the teaching of science in elementary school?	<p>(a) The teachers' perceptions of the importance of having a strong science program in elementary school were reported as very high. Mean: 5.43 out of 6.</p> <p>(b) The teachers' feelings about integrating science into other subject areas and vice-versa were reported as very positive. Mean: 5.39 out of 6.</p>

Research Question 2

Research Question 2 asked to what extent can schools' state science assessment scores be predicted from the level of science kit usage by teachers and other related input variables, as controlled by various school and teacher demographic variables?

By analyzing all of the teacher responses to my survey, I was able to develop a multiple regression equation to answer this research question. As stated in Chapter IV, the equation is as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4$$

where y is the estimated dependent value, β_0 is the estimated y-intercept, β_1 is the estimated coefficient for x_1 (teacher

confidence), β_2 is the estimated coefficient for independent variable x_2 (success of learning outcomes), β_3 is the estimated coefficient for x_3 (beliefs about teaching science in elementary school) and β_4 is the estimated coefficient for x_4 (% usage of NSLP).

In order to do this, some of the input variables and some demographic data had to be excluded because of the minimal correlation they had to the dependent variable, the schools' 5th grade state science assessment scores. Listed here are the independent variables that had that minimal correlation: level of science kit usage including the inquiry-based experiments, assessments and associated science reading writing and journaling activities ($p = 0.2672$); support levels from the school, district and regional math and science center ($p = 0.2197$); quality of professional development from the kit designers (0.1625); years of teaching (0.0963); years of using the kits (0.5910); and major or minor in science (0.3488). Even though the perceived value of aspects of the science kits in helping students learn science concepts had a good significance level with the 5th grade state science exam ($p = 0.0010$), it was excluded because of the strong correlation it had with the perceived success related to science student learning outcomes ($p = <.0001$). That is to say that these two independent variables were essentially the same, so one had to be deleted.

Therefore, after doing the statistical analysis on all of the data, the only independent variables that showed a significant correlation to the dependent variable, the schools' 5th grade state science assessment scores, were: (1) the confidence levels in teaching elementary school science ($p = 0.0497$), (2) the perceived success related to

science student learning outcomes ($p = 0.0014$), (3) beliefs about teaching science in elementary school ($p = 0.0476$), and (4) NSLP percentage ($p < 0.0001$).

My data confirmed the importance of these four variables in this study. For the independent variable for teachers' perceptions regarding the confidence levels in teaching elementary school science using the kits as a resource, the data reflected: a high mean value of 4.82 out of 6 for the increase in teacher confidence; a high mean of 4.68 out of 6 for the teachers' feeling about their ability to teach science better; a little over half of the teachers reported a favorable response about writing lesson plans and experiencing enjoyment in teaching science with means of 4.53 out of 6 and 4.36 out of 6 respectively; but when addressing the amount of time to teach science lessons, the teachers responded with a rather low mean response of 3.49 out of 6.

For the independent variable for the teachers' perceived success related to science student learning outcomes, the data reflected: about half of the teachers felt that their students were meeting their science outcomes and understanding with a mean score of 4.26 out of 6; teachers perceptions of student excitement about doing science was good at 4.56 out of 6; but the experienced teachers reported a lower response concerning this variable with a mean score of 3.83.

For the independent variable concerning the teachers' perceptions about their beliefs regarding the teaching of science in elementary school, the data reflected: the scores showed a strong mean of 5.43 out of 6 for their beliefs and an equally strong response mean of 5.39 out of 6 for integrating science into other subject areas and vice-versa.

For the importance of having the National School Lunch Program data in this study, one should review the research of Harwell and LeBeay (2010), Leventhal and Brooks-Gunn (2000) and Brogan (2009) found in Chapter II to better understand the correlation between the percentage of students enrolled in the National School Lunch Program and academic success.

The R^2 value for this study was .796 which is quite good. This value can be expressed as a percentage and one can say that approximately 80% of the variance in the dependent variable, the MEAP score, can be accounted for by the four independent variables in the study. Again, the four independent variables in my study were confidence levels in teaching elementary school science, the perceived success related to science student learning outcomes, the beliefs about teaching science in elementary school and the school's percentage of students eligible for the National School Lunch Program.

Discussion and Relationship of Results to Existing Studies

In Chapter II, I researched the literature concerning the various components included in my research. The findings of these research studies and the findings of my study are addressed in this section.

Riggs and Enochs (2006) addressed teacher self-efficacy in teaching science and what might contribute to their behavior in the classroom. In discussing teachers' feelings about teaching science in elementary school, they stated that "attitudes to science and consequent teacher behaviors may arise because of teachers' beliefs about their ability to teach science and children's ability to learn science" (p. 626). The teachers in my study responded with survey answers indicating similar beliefs as Riggs and Enochs. The

highest ratings from my survey dealt with teacher self-efficacy or self-confidence, and with such self-confidence, came the teachers' feeling that they could teach better than they did before the kit program, hold the students' interest better, experience teaching science as an enjoyable activity, and maintain the students' excitement about using the experiments found in the kits. These finding also go along with the previous comments found in Ramey-Gassert et al.'s (1996) study that gave greater insight into how teachers "develop science teaching efficacy beliefs, richer insights into their professional growth experiences, and other factors which lead to highly efficacious science teaching" (p. 285).

Concerning barriers that teachers find to implementing good science instruction in their classrooms, Lee and Houseal (2003) made a very poignant comment by stating,

The literature is rich in studies on the factors that constrain teaching elementary school science. These can be divided into two general categories: (1) external and (2) internal factors. External factors include time; money; supplies; materials and equipment; classroom management; dealing with diverse learners and individual differences; and support from colleagues, administrators, and the community. Internal factors include content preparation, self-confidence levels, anxiety, attitude, and professional identity toward teaching science. (p. 37)

The responses from the teachers in my study address many of these issues. Of the external factors affecting good science teaching, time to teach science was mentioned as the biggest concern. Only 26% of the teachers responded with an "agree" or "strongly agree" to the survey statement that they had sufficient time to complete their science lessons. The survey findings in my open-ended questions reflected that the lack of time to complete the lessons found in the kits is the number one problem with the program.

This result was also verified by many teachers I have personally talked to in the past and while doing this research. Along with this concern for the time to complete the lessons in the kits, goes the teachers' concerns about fighting other subjects for time just to teach science.

These findings match the information I received in the open-ended questions about the lack of administrative support at every level. For example, when addressing the support the teachers receive for implementing the kit program into their schools, the teachers responded by saying that there is very little support for science in elementary school and a great emphasis is placed upon math, ELA and social studies. Teachers are being asked to do more and more in their teaching day and cutting science teaching time seems to be an easy solution used by administration to give more time to other subjects.

The participating teachers in my study also reported that the logistics of obtaining the kits and its materials was very good, but the professional development they were provided was only average. Lastly, they reported that the external factors such as local and state testing placed a burden upon their teaching practices. As far as internal factors go, the teachers reported that they received very little support from their respective principals affecting content preparation and self-confidence levels. A similar response was received concerning the principals' provision of time for mentoring, discussing science lessons and providing money for additional science training. The responses for district support were essentially the same as the support provided by the principals. Support for the science curriculum was sufficient but the availability for additional training for teaching science was reported as very low. Along these lines, concerning

the support needed from the school's principal, while implementing the science kit program, Dickerson et al. (2006) stated:

If teachers exhibit greater confidence in their science teaching by using kits, it is logical to conclude that a systemic implementations of kits in a school district would make a difference for teachers who dislike science and/or who lack confidence in teaching science. (p. 49)

When discussing the results from the survey pertaining to the importance of having a strong science program in elementary school, the teacher ratings were extremely positive. Esbach (2007) is a big proponent of starting science education in elementary school. He pointed out the following about child development and learning by stating:

Development of attitudes toward science starts at the early stages of life.

Exposing students to science in environments where they can enjoy science develops positive attitudes towards science; and early exposure to scientific phenomena leads to better understanding of the scientific concepts studied later in a formal way. (p. 167)

From the open-ended responses, many teachers feel that it is very important to have a strong science program in elementary school but are very frustrated with the administration while trying to implement and integrate their science program among the ELA, math and social studies lessons.

Young and Lee (2005) expressed the importance of professional development in schools adopting science kits for their elementary school teachers to use in their classrooms. Since many elementary teachers are not well versed in science content or the skills of teaching elementary school science, professional development is especially

important for them. The responses in my study concerning the professional development provided by the regional math and science center were mediocre as far as excellence, meeting teacher's needs, and ease of understanding. I was surprised by the responses on the quality of the professional developments. From my years of working closely with the teachers who provide the professional development, I thought that they would receive a much higher evaluation. Since I have a good background in the sciences, the statement one teacher raised in the open-ended questions comes to the forefront. This teacher stated that: "The kits are written by people with a good science background for teachers with a good science background." This also addresses the questions as to how much science background an elementary school teacher needs to teach science successfully.

Fleury and Bentley (1991) discussed the importance of the teacher and his or her qualities and strengths in the field of science that contribute to student learning. With this in mind, they introduce the thoughts of Yager (1989) who "... argues that of all the elements involved in a school's science program, teachers are the most crucial components for student success in learning science" (p. 33). Stake and Easley (1978) stated that many elementary school teachers lack a strong background in the sciences which can appear in the elementary school science curriculum. In my study, 41.1% of the teachers have a major or minor in undergraduate science. My data does not necessarily answer the questions as to the importance of elementary school teachers having a good science background, but with or without these majors or minors in science, a very high percentage of teachers reported that they are now quite comfortable with teaching science by using the content of the kits as their primary resources. Appleton (1995) tied the amount of science background a teacher has to the self-confidence that

teacher has in teaching science in their elementary schools. But, he also addresses the fact that having a considerable amount of science background may actually cause problems where these teachers try to lecture their knowledge into their students, rather than properly using inquiry-based instruction as the kit program requires.

In addressing the use of inquiry-based instruction, Foley and McPhee (2008) stated that research shows that inquiry-based curriculum materials, in comparison with traditional teaching methods, work better to help students engage in, reflect on, and apply scientific knowledge and science process skills and perform better on assessments than traditional methods. The responses to my survey reflected very positive answers about the teachers' perceptions about student engagement and excitement about doing the experiments in the kits. They also reflect a moderately positive response on process skills and learning scientific knowledge.

Blanchard et al. (2011) reported that higher frequency kit users were more likely than low kit users to report having students engaged in inquiry-related instruction that required students to explain concepts just as the lower frequency kit users were more likely to have students engaged in traditional forms of instruction. In my study, positive responses on kit usage were received on doing science experiments, comfort, and enjoyment of teaching science while using the kits. Other components found in the kits received lower acceptance by the teachers; namely, use of assessments, use of industrial journals, and use of recommended pre-reading and pre-writing times.

When discussing assessments, the moderate rating responses on the survey matched up with the information I received in some of the open-ended questions.

In my study, the correlation of the fairly positive ratings on the use of assessments seems to match the comments of Black and Wiliam (1998). They expressed their thoughts about pre-service teachers learning the importance of classroom assessment and how to use it, and the importance of continuing professional development in helping the new teachers have the time and support to evaluate their assessment methods and make changes if necessary. Considering the comments on student journal use, namely: not enough time to use them, they are too dull, and my students cannot write in them well etc., I am surprised with the 73% response rate for usage. The response rate for the value of the journals of 62% is interesting and raises this question: Why would a teacher use them if they do not place that much value on them? The high response rate for using the journals might be because of the fairly high expectation to use them.

In the open-ended questions, I found that while many of the teachers were not very excited about using the industrial journals, others were asking for more in order to make “real life” connections with their students.

During this study, when addressing the use of the student journals found in the kits, one finds a fairly positive response along with the teachers attempts to integrate science into other subject areas. The use of the reading and writing components found in the student journals are considered important in any science curriculum. Glynn and Muth (1994) discussed the importance of teachers having a scientific literacy curriculum in order for students to learn meaningful science. They say, “In a scientific literacy curriculum, reading and writing can serve as dynamic vehicles for learning science meaningfully” (p. 1057).

When discussing the low teacher responses from the experienced teachers, one finds a rating of 19% for a consistent growth in science kit usage. One can see this trend by looking at the raw survey data which shows a goodly number of teachers not using or just minimally using components such as assessments, reading and writing and journals found in the kits. But on the other hand, when the questions is asked in the survey if they enjoy teaching science with using the kits, there is a very positive response.

Along these lines, the survey showed that only 19% of the teachers have seen their time to teach science remain the same or increase. Essentially, the time to teach science in elementary school today is the same as it was 20 years ago (National Center for Educational Statistics, 2011)

Darling-Hammond (2000) stated that some feel that the best teachers are the ones with the most experience, but research has revealed that after several years of teaching, experience does not really play a role to any great extent. Teacher demographics reflected the years of teaching and the years of using the kits as found in Table 2, but no statistically significant connections to the MEAP scores were identified.

Brogan (2009) stated that, in general, low SES districts have fewer resources and have less experienced teachers because they receive lower pay and work under more difficult conditions. Therefore, these districts have lower academic achievement, fewer high school graduates and fewer students going to college. In my study, the results collected on this demographic had significant effect on the multiple regression equation.

Table 22 offers a summary of my findings as connected to other research.

Table 22

Comparison Summary between Rice (2016) and Previous Research

Key Findings (Rice, 2016)	Previous Research
Using Science Kits in the Classroom	
<ul style="list-style-type: none"> The statement that science kit usage gives teachers more confidence in teaching science in their classrooms was recorded with either an “agree” or “strongly agree” rate of 75%. 	<p>Affirms the high 75% response</p> <ul style="list-style-type: none"> If systematic introduction of science kits gives teachers more confidence in teaching science, it makes sense to say that the use of these kits would make a difference for teachers who dislike science and/or who lack confidence in teaching science (Dickerson et al., 2006). Also 96% of the workshop participating teachers reported a better attitude toward science because of attending workshops and using the kits (Rubino, Barley, & Jenness (1994). Riggs and Enochs, (2006) stated “attitudes to science and consequent teacher behaviors may arise because of teachers' beliefs about their ability to teach science and children’s ability to learn science” (p. 626). (Ramey-Gasser et al., (1996) gave insight into how teachers “develop science teaching efficacy beliefs, richer insights into their professional growth experiences, and other factors which lead to highly efficacious science teaching” (p. 285). Appleton, (1995) tied the amount of science background a teacher has to the self-confidence that teacher has in teaching science in their elementary schools. Darling-Hammond (2000) stated that some feel that the best teachers are the ones with the most experience, but research has revealed that after several years of teaching, experience does not really play a role to any great extent.
<ul style="list-style-type: none"> Teachers felt that it was difficult to complete the kit science lessons within the allotted time and only 26% reported the ability to do so, as an “agree” or “strongly agree.” 	<p>Affirms the low 26% response</p> <ul style="list-style-type: none"> Time was a significant concern for both teachers (Jones & Eick, 2007); alterations were an adaptation to time constraints (Jones & Eick, 2007); Teachers also enjoyed teaching with the science kits but did complain from time to time about the time involved in setting up some of the experiments (Houston, Frasere, & Ledbetter, 2008); Setting up experiments and giving the students enough time to complete them took more time than initially contemplated (Jones & Eick, 2007). Lee and Houseal, (2003) identified time as one of the external factors that constrains teaching elementary school science.

Table 22 – continued

Key Findings (Rice, 2016)	Previous Research
<ul style="list-style-type: none"> Teachers at the rate of 89% recorded a response of “agree” or “strongly agree” for the importance of having a strong science program in the elementary school curriculum. 	<p>Affirms the high 89% response</p> <ul style="list-style-type: none"> The school administration along with the community must advocate for a good elementary school science program (NSTA, 2002). Esbach, (2007) stated that, development of attitudes toward science starts at the early stages of life. Exposing students to science in environments where they can enjoy science develops positive attitudes towards science; and early exposure to scientific phenomena leads to better understanding of the scientific concepts studied later in a formal way.
<ul style="list-style-type: none"> Teachers at the rate of only 22% recorded a response of “agree” or “strongly agree” that implementation of the kit program is well monitored in their building by the school principal. 	<p>Affirms the low 22% response</p> <ul style="list-style-type: none"> In the search for factors that influence school effectiveness, the role of the elementary school principal has emerged as critical (Leithwood & Montgomery, 2014).

District Provisions

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| <ul style="list-style-type: none"> Only 25% of teachers reported with an “agree” or “strongly agree” response to the statement that they receive sufficient additional training for teaching science in their classroom. | <p>Affirms the low 25% response</p> <ul style="list-style-type: none"> Teachers need opportunities to deepen their knowledge of the science content of the K-8 curriculum (Duschi et al., 2007). Fleury and Bentley, (1991) discussed the importance of the teacher and his or her qualities and strengths in the field of science that contribute to student learning. Along with the comments about the quality and strengths of a teacher, Yager, (1989) pointed out that the most important element in a good science program is the teacher. And along with this importance goes the concerns of Stake and Easley, (1978) who stated that many elementary school teachers lack a strong background in the sciences which can appear in the elementary school science curriculum. Along with these support statements goes the comments of Brogan, (2009) who stated that in general, low SES districts have fewer resources and have less experienced teachers because they receive lower pay and work under more difficult conditions. |
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Principal Provisions

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| <ul style="list-style-type: none"> Principals providing time for mentoring, discussing science lessons and providing money for additional science training were reported with “agree” or “strongly | <p>Affirms the low responses of 27%, 23% and 22%</p> <ul style="list-style-type: none"> Case study results support the notion that reform is complex and personal, and teachers as professionals need collective and individual |
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Table 22 – continued

Key Findings (Rice, 2016)	Previous Research
agree” at a rate of only 27%, 23% and 22% respectively.	support in the classroom as they make incremental changes in practice toward becoming inquiry-oriented teachers (Jones & Eick, 2007); Administrators can provide science teacher support by providing appropriate materials, recognizing exemplary science teachers and encouraging special science activities (NSTA, 2002).

Professional Developments

- The kit using teachers reported an “agree” or “strongly agree” at a rate in the 50% range for overall quality of the professional developments provided by the regional math and science center.
- Equivocal with a response of 50%
- Bottom-up cases of adaptation are worth studying in order to make professional development more insightful and to account for the development of practical knowledge (Jones & Eick, 2007); professional developments need to be elaborated upon if teachers are to partake in professional development programs guided by the national standards (Posnanski, 2002). Young and Lee, (2005) expressed the importance of professional development in schools adopting science kits for their elementary school teachers to use in their classrooms. They go on to say, since many elementary teachers are not well versed in science content or the skills of teaching elementary school science, professional development is especially important for them.

Use and Value of the Kit Materials

- On reporting about the use frequency of the kit materials, the highest score of “most of the time” or “always” was recorded at 67% for use of the inquiry bases experiments.
- Affirms the moderate 67% response
- Science kits provide all the materials for teachers to conduct inquiry lessons and have been a growing trend in some countries like the United States, Australia and Canada (Jones, Robertson, Gardner, Dotger, & Blanchard, 2012). Foley and McPhee (2008) stated that research shows that inquiry-based curriculum materials, in comparison with traditional teaching methods, work better to help students engage in, reflect on, and apply scientific knowledge and science process skills and perform better on assessments than traditional methods. Blanchard et al., (2011) reported that higher frequency kit users were more likely than low kit users to report having students engaged in inquiry-related instruction that required students to explain concepts just as the lower frequency kit users were more likely to have students engaged in traditional forms of instruction.

Table 22 – continued

Key Findings (Rice, 2016)	Previous Research
<ul style="list-style-type: none"> The use and value of the industrial journals contained in the kits received a very low response of, “most of the time” or “always,” at a 24% rate and a response of, “significant value” or “very valuable,” at a rate of 18% respectively. 	<p>Affirms the low 18% and 24% responses</p> <ul style="list-style-type: none"> Any method to enhance teaching elementary school science by promoting technology such as found in industrial journals has a significant potential to improve student understanding of modern day science (Slavin, Hanley, & Thurston, 2012); Literacy skills can be well developed in students by use of science trade books (NSTA, 2002).
<ul style="list-style-type: none"> For the value of the inquiry-based experiments contained in the kits, the teachers reported a response of “significant value” or “very valuable” at a rate of 73%. 	<p>Affirms the high 73% response</p> <ul style="list-style-type: none"> When teachers replace science textbooks with activities that engage and excite students, there will be an increase in student understanding of science and the kids’ attitudes about science (Dickerson et al., 2006).
<ul style="list-style-type: none"> The use of student journals received a “most of the time” or “always” rating of 73% for use by the teachers and a value rating of “significant value” or “very valuable” of 62% by the teachers. 	<p>Affirms a high response of 73% and a moderate response of 62%</p> <ul style="list-style-type: none"> Student journals can be used as an alternative source of student growth (Young, 2003); Tools like interactive science journals give the students a chance to think, to reason, and to be creative with their science abilities. Higher levels of thinking are involved with journals which make the learning more meaningful (Azimioara, Bletterman, & Romero, 2004).

Formative and Summative Assessments

<ul style="list-style-type: none"> The expectation for use of the assessments in the kits received an “agree” or “strongly agree” rating of 63%. 	<p>Affirms a moderate response of 63%</p> <ul style="list-style-type: none"> Assessments must be considered an essential part of any good elementary school science curriculum. Student performance in science can be improved with the use of formative assessment, especially the lower performing students (Dunn & Mulvenon, 2009); Black and Wiliam (1998) provided a general definition for assessments to include all the ways a teacher can get information from their students to show that they are understanding the material. Their definition does not only include exams, but also includes homework, observations and classroom discussions.
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Table 22 – continued

Key Findings (Rice, 2016)	Previous Research
Pre-reading and Pre-writing	
<ul style="list-style-type: none"> Pre-reading and pre-writing times were not well received by the teachers. The participating teachers reported a “most of the time” or “always” for pre-reading and pre-writing was reported at 38% and 31% respectively. 	<p>Affirms the low responses of 38% and 31%</p> <ul style="list-style-type: none"> Glynn & Muth, (1994) stated that, “In a scientific literacy curriculum, reading and writing can serve as dynamic vehicles for learning science meaningfully” (p. 1057).
Change of Science Teaching Time	
<ul style="list-style-type: none"> The change in time to teach science has received a response of “Increased some” or “Increased a great deal” of 19%. 	<p>Affirms the low response of 19%</p> <ul style="list-style-type: none"> As of 2011, only 10% of today’s educational time is devoted to teaching science and it essentially does not increase and may decrease (National Center for Educational Statistics, 2011). Essentially, the time to teach science in elementary school today is the same as it was 20 years ago (National Center for Educational Statistics, 2011)
Consistent Growth in the Kit Program	
<ul style="list-style-type: none"> The growth of the kit program usage received a rating of 19% for responses of “agree” or “strongly agree.” 	<p>Affirms the low response of 19%</p> <ul style="list-style-type: none"> The use of science kits in elementary school is increasing in the United States, Australia and Canada (Rubino, Barley, & Jenness, 1994).

Implications for Future Research

The limitations of this study have implications for future research. From being a secondary school teacher for 25 years, I know personally how difficult teaching can be. I also know that teaching elementary school is considerably more difficult than teaching at the secondary level since I have done both. A good number of open-ended responses reflected the fact that it seems like administrators continually place more demands upon the teachers and this has become a major problem in elementary schools where the teachers are considerably overloaded with the requirements of teaching multiple subjects, and with the expectation of the students doing well in all state subject area exams. Some

of the teachers stated that it seems like some of them cannot spare one more minute in their busy day. This is what I found when I sent out my surveys in that only approximately 18% of the teachers found 8-10 minutes to complete my survey. It was disappointing when I received only two survey responses from one of the largest school districts in the state. This was somewhat expected after I spoke with the math/science leader for that district and was told that their teachers were already overworked and she does not want me to flood them with unnecessary emails and requests for their time. Therefore, if I were to redo this study, I would have made a greater effort to contact the science leaders in the participating schools, prior to sending out my surveys, and ask them for their assistance in getting their teachers to participate in the study.

If I were to investigate this topic again, I would address the subject of professional developments in more detail. From my experiences with the professional developments provided by the regional math and science center, I considered them to be excellent and to provide the much needed support the participating teachers could use in their classrooms. But after speaking with many teachers and analyzing my survey, I found that many of the teachers felt that these professional developments are not as good as I previously thought. My feeling were coming as an experienced teacher with a very strong science background, while many of these participating teachers were on the other end of the spectrum of knowledgeable and science teaching experience.

Another aspect of this research I would investigate if I were to repeat this study is several limitations partially addressed in Chapter III. The one limitation mentioned in Chapter III dealt with the understanding of the beliefs of the teachers completing my survey. I believe that my results could be biased to some extent by the teachers who took

time to complete my survey. One might think that the teachers who completed the survey might be more involved in the kit usage in their schools and more interested in informing the kit developers as to what would make the product more user friendly. After reviewing the responses to the open-ended questions, I tend to believe that, but there were some responders that reported a more negative and frustrating situation with their kit usage. Another limitation could have been the wording or definition of certain questions. Specifically, after reviewing my survey, I think that the word “growth” as in survey question 11 could have been misunderstood. If teachers understood the word “growth” differently, the responses to that question could be somewhat misleading. It was meant to ask the seasoned teachers if they have seen progress made in the use of the kit program in the areas listed in survey question 11.

Another idea I might entertain in future studies is to make the research a quantitative/qualitative mixed methods project. While a survey can help identify many perceptions about a certain subject area, I feel that personal contact and questioning of the participants could lead to better insight into how to make improvements for the elementary school teachers who struggle, in one way or another, in teaching science.

Along these lines, a second area I would delve into deals with the responses from the experienced teachers about the lack of consistent growth of the kit program in their schools. Possibly by investigating the real reasons underlying this lack of growth, a researcher could provide meaningful suggestions for further positive change.

Implications for Policy, Practice, and Organization

In my study, I was disappointed in the responses from the more experienced teachers about minimal consistent growth in the kit program. With the

proper district and school leadership, improvements should continue in a positive direction if these individuals maintain a positive attitude about science education and maintain a close relationship with the regional math and science center. From what the participating teachers reported in the open-ended questions, time to teach science and the lengthy lessons were of the biggest concern. The fault of this concern lies with a number of people who have the ability to correct what appears to the teachers as an insurmountable task. The regional math and science center needs to understand and address the concerns of the teachers as to the length of the lessons, the appropriateness or inappropriateness of the assessments, and quality and the use of the student journals and so on. This time issue was discussed with the regional math and science center and they stated that originally, the kits were designed to meet the needs of the teachers where science was considered to be a daily subject taught along with math, ELA etc. Since this is not the fact, the kits have been modified in an attempt to assist the teachers with the time problem. The center reported that there are fewer lessons over all per unit and each unit now gets 12 weeks for instruction instead of 8 weeks. They did not modify lesson length because they thought by doing so, it would have an effect on the depth of instruction and knowledge (N. Karre, personal communication, July 7, 2016).

The regional math and science center also needs to listen to the participating teachers as to what they really want in the professional development classes the center offers. Here is another example of where there is improper communication, or just a lack there of, causing the elementary school teacher unneeded stress. The school district needs to work closely with the school principles in order to develop the proper teaching times for science in their elementary schools. And lastly, the principals need to furnish

the appropriate support for the teachers in order to implement science education into their curricula. I have seen this work well in some districts and all concerned seem to be quite happy and confident in their elementary school science programs (J. Hadik, personal communication, April 19, 2016). So from personal experience and information received from cooperative districts, I know it can work. All we need to do is get the responsible individuals to do their jobs that the community is paying them to do. If all of the involved personnel in elementary school science education have a very good open communication system, the so dearly sought after consistent growth in the kit program could actually be seen and appreciated by all of the individuals involved in our children's education.

Now that we are in the 21st century, we see the need for a strong science program more than ever. Technology is increasing at a very rapid rate, other countries are teaching and graduating more students in the science and technology fields making job opportunities for our students more competitive. We need good science education starting at the earliest levels in order for our students to be the best and most competitive employers and employees in the world. Researchers such as Geier et al. (2008) and Minner et al. (2009) continue to show with their work that students using inquiry-based instruction with science kits score better on state science exams than do schools using the traditional teaching style. Therefore, many in science education feel that the basis for our children becoming excellent science students is through science education using inquiry-based instruction.

It is my hope that schools will use the multiple regression equation that has resulted from this study and plug into it their own data so they can see what areas are

affecting their 5th grade state science exam scores the most, and then determine what areas of improvement would have the most affect on increasing the scores. If we can be the world's leader in whatever area we put our minds, money and efforts toward, why not become the top country in the world in science education? This is DEFINITELY DOABLE people!! Our children must do well on this "SPECIAL TEST" or else; as Seuss, Prelutsky and Smith (1998) so wisely stated:

All schools for miles and miles around
 Must take a special test
 To see who's learning such and such –
 To see which school's the best.
 If our small school does not do well,
 Then it will be torn down,
 And you will have to go to school
 In dreary Flobbertown. (p. 21)

AND

**I want my kids in Diffendoofer Schools and not Flobbertown Schools where the kids
 all look alike, dress the same and always walk in single file !!!**

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Appendix A

Survey Instrument

*Regional Math and Science Center Teacher Survey on the Usage of the "Science
Unit Kit Program"*

Regional Math and Science Center Teacher Survey on the Usage of the "Science Unit Program"

PLEASE READ THIS CONSENT INFORMATION BEFORE YOU BEGIN THE SURVEY

In an attempt to acquire knowledge about the implementation of the "Science Unit Program," we are inviting you to participate in a survey study.

It will take less than 10 minutes. When you are done, you have the opportunity to win one of five \$50 gift cards to amazon.com. Your input will be very important in our process of updating our "Science Unit Program." We know how pressed you are for time in your busy day and we really appreciate you giving us a few minutes to complete this survey.

Your responses will be coded and kept confidential. At the end of this study, your responses will be given to a Western Michigan University doctoral student for analysis and use in his doctoral dissertation. The analysis will be furnished to the Regional Math and Science Center so improvements can be made to the program.

When you start this survey, you are consenting to participate in the study. If you do not consent, simply exit now. If, after beginning the survey, you decide you no longer wish to continue, you may stop at any time. You may also choose not to respond to a particular question for any reason. What is important is that you answer each question as honestly as you can.

Since this survey will be used by a Western Michigan University doctoral student, it has been approved by the Western Michigan University Human Subjects Institutional Review Board (HSIRB).

Should you have any question prior to or during this study, you can contact the Regional Math and Science Center:

- Susan Buckham, Executive Director of the Regional Math and Science Center

Thank you in advance for your participation in this study. It is greatly appreciated.

1. In using the "Science Unit Program," I feel

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
a. very confident in teaching science in my classroom	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. I can better teach science to my students	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. my students love doing the experiments contained in the kits	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. my students experience great success meeting the student outcomes for science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. there is very consistent growth in students' understanding of science concepts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. there is a very consistent growth in students' excitement about learning science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. it is very easy to write my lesson plans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. it is very easy to complete each lesson within the allotted time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. it is very easy to maintain the students' attention throughout the lessons	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. it is an enjoyable teaching experience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. the kits contain a sufficient amount of materials for each experiment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
l. the reading and writing for each kit is grade level appropriate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
m. it is very important to have a strong science program in the elementary school curriculum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
n. it is very important to integrate literacy and math into my science lessons and vice versa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
o. its implementation is closely monitored in my building to ensure I am using all recommended elements of the program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. My district has provided:						
	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
A comprehensive science curriculum for me to use with my students	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sufficient additional training for teaching science in my classroom beyond the unit kit training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. My principal has provided:

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
a. sufficient mentoring or a mentor for my science teaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. sufficient encouragement for my science teaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. sufficient money for attending other science trainings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. sufficient time to discuss my science teaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. all needed literacy trade books that go along with the science kits	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. The Regional Math and Science Center has provided:

	Strongly Disagree	Disagree	Slightly Disagree	Slightly agree	Agree	Strongly Agree
a. timely delivery of the science units	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. timely delivery of any missing program materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. timely return of text or phone requests for assistance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. quality Professional Development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. The Professional Development I have received on the "Science Unit Kit Program" has been

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
a. very timely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. very supportive of my needs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. very easy to attend	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. excellent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. constructed in a way that makes the material easy to understand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. sufficient to meet my needs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. For these "Science Unit Program" elements, how often do you consistently use them within each unit?

	Never	Hardly Ever	Not Very Often	Some of the Time	Most of the Time	Always
a. inquiry-based experiments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. formative assessments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. summative assessments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. recommended pre-reading time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. recommended pre-writing time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. recommended reading integration-time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. industrial journals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. student journals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. For these "Science Unit Program" elements, how valuable is each in helping your students learn science?

	Do not use	Very limited value	Some value	Moderate value	Significant value	Very valuable
inquiry-based experiments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
formative assessments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
summative assessments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
recommended pre-reading time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
recommended pre-writing time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
recommended reading integration-time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
industrial journals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
student journals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. For the formative and summative assessments provided with each "Science Unit,"

	Strongly Disagree	Disagree	Slightly disagree	Slightly Agree	Agree	Strongly agree
a. there is a very close relationship between the assessments and students' understanding	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. the assessments match very closely with the material covered in the unit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. there is a strong expectation for me to use them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. For the Student Journals provided in each "Science Unit," I find

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly agree
a. that most of my students complete them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. that most of my students enter quality work in their journals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. there is a strong expectation for me to use them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. Have you been teaching for 3 years or more at your present school?

☐ Yes

☐ No

Regional Math and Science Center Teacher Survey on the Usage of the "Science Unit Program"

11. During my time at my present school, I have seen very consistent growth in the:

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
a. "Science Unit Program" implementation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. support for the "Science Unit Program"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. students' understanding of science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. students' excitement about science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. teacher's self confidence in using the "Science Unit Program"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. To what extent has the amount of time you have to teach science each week changed in the past 3-5 years:

- ☐ decreased a great deal
- ☐ decreased some
- ☐ decreased minimally, but essentially the same
- ☐ increased minimally, but essentially the same
- ☐ increased some
- ☐ increased a great deal

Regional Math and Science Center Teacher Survey on the Usage of the "Science Unit Program"

13. Gender:

- ☐ Male
- ☐ Female

*** 14. Please enter your school name below. This is VERY IMPORTANT because without it, we have no way to match your survey responses with your school.**

15. I have:

	Yes	No
a. received Regional Math and Science Center training on the units I will be teaching this year	<input type="radio"/>	<input type="radio"/>
b. received Professional Development specific to the next Generation Science Standards" (NGSS) or the "Science Framework"	<input type="radio"/>	<input type="radio"/>
c. an undergraduate major or minor in science	<input type="radio"/>	<input type="radio"/>

16. How many years (as rounded to the nearest year) have you been

a. teaching

b. using the "Science Unit Program"

17. If you have attended any Professional Developments in science during the last year, other than the training for the "Science Unit Program," please identify the professional development below.

18. Which grade level/s are you using the "Unit Science Program" in this school year?

- ☐ Kindergarten
☐ First Grade
☐ Second Grade
☐ Third Grade
☐ Fourth Grade
☐ Fifth Grade
☐ Sixth Grade

19. In the past, which grade level/s have you used the "Unit Science Program" in?

- ☐ Kindergarten
☐ First Grade
☐ Second Grade
☐ Third Grade
☐ Fourth Grade
☐ Fifth Grade
☐ Sixth Grade

20. Please share with us your favorite unit/s you teach or have taught and why.

21. Please share with us any comments or concerns that you might have with your usage of the "Science Unit Program."

**THANK YOU FOR PARTICIPATING IN OUR SURVEY.
YOUR FEEDBACK IS VERY IMPORTANT TO US.**

22. If you would like to be entered into a drawing to possibly win one of five \$50 gift cards from Amazon, please enter your e-mail address below. This information will only be used for the drawing and not be linked in any manner to your individual responses.

Appendix B
E-mail Messages to Participants

Appendix B1

Initial E-mail to Participants

Dear Elementary School Teachers,

I write to invite you to participate in a study which will investigate your perceptions of teaching elementary school science using the Regional Math and Science Center's "Unit Science Kit Program."

As someone who has used the science kits, only you can provide the Center with the information necessary for improving the science kits.

I know how busy you are, so as an extra incentive for completing a survey, you will be able to enter a randomized drawing to win one of five **\$50 gift certificates** to Amazon.com at the end of the survey. Entering or not is entirely up to you.

You should be able to complete the survey in less than 10 minutes.

If at all possible, please provide the Center with your input by _____, 2016.

If you have any questions, please feel free to contact me via e-mail at (blank) or by telephone at (Blank).

Thank you for your time and consideration.

Sincerely,

Regional Math and Science Center Executive Director

Appendix B2

First Reminder Notice

Dear Educator,

Recently, you received an e-mail from us which asked for your input into possible ways the Regional Math and Science Center can improve the “Unit Science Kit Program.”

If you have already responded, thank you very much for you input. If not, please do so by clicking on the link below.

At the end of the survey, you will have the option to enter a drawing to win one of five **\$50 gift certificates** to Amazon.com. If you have completed the survey, thank you very much for your assistance in this very important research.

Click this link to begin the survey:

Sincerely,

Regional Math and Science Center Executive Director

Appendix B3

Second Reminder Notice**NEEDED !!!
ELEMENTARY SCHOOL
TEACHERS'**

perceptions of teaching elementary school science using the Regional Math and Science Center's "Unit Science Kit Program"

PLEASE – Find a few minutes in your busy day to help us collect your perceptions about your teaching experiences using our "Unit Science Kit Program" and possibly winning a **\$50 gift certificate** to Amazon.com while doing so. If you have already completed the survey, thank you very much for your assistance in this very important research.

Simply click this link to begin the survey:

Thank you very much !!

Regional Math and Science Center Executive Director

Appendix C

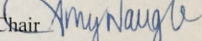
Human Subjects Institutional Review Board Letter of Approval

WESTERN MICHIGAN UNIVERSITY



Human Subjects Institutional Review Board

Date: January 12, 2016

To: Sue Poppink, Principal Investigator
Tony Rice, Student Investigator for dissertationFrom: Amy Naugle, Ph.D., Chair 

Re: HSIRB Project Number 16-01-02

This letter will serve as confirmation that your research project titled "A Quantitative Analysis of Whether Elementary Teachers' Science Kit Usage and Beliefs Can Predict State Science Assessment Scores" has been **approved** under the **exempt** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may **only** be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., ***you must request a post approval change to enroll subjects beyond the number stated in your application under "Number of subjects you want to complete the study."*** Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: January 11, 2017

1903 W. Michigan Ave., Kalamazoo, MI 49008-5456

PHONE: (269) 387-8293 FAX: (269) 387-8276

CAMPUS SITE: 251 W. Walwood Hall

Appendix D

Responses to the Open-Ended Questions

Teacher Survey on the Usage of the “Science Unit Program”

Survey Free Response Questions

QUESTIONS ADDRESSED: These are recorded here exactly how the teachers responded (without any changes).

Q17: If you have attended any Professional Developments in science during the last year, other than the training for the "Science Unit Program," please identify the professional development below.

Q20: Please share with us your favorite unit/s you teach or have taught and why.

Q21: Please share with us any comments or concerns that you might have with your usage of the "Science Unit Program."

District A

School 1

20. Hmm... kids have really liked States of Matter... who can resist slime?

20. Five Senses

21. Each year we start out with the unit "Our Earth". While the experiments and kit is appropriate, the journal pages are way too difficult for beginning of the year Kindergarten. There is far too much writing for students who are not yet able to write.

School 2

20. Plants Unit Second Grade. Students like to come up with different ways to see how they plants will grow. For example, only watering with Coke or putting the plant in a dark closet.

21. The training for each grade level is not needed. Each year for the past three years I have been moved from my grade level. Each time I have to attend a week long training that is essentially the same training. This has created a negative attitude towards the implementation of the program. Additionally, the planning takes far to long. I have about 20 minutes a day for planning all of my subjects. I can't read the entire lesson and prep in that 20 minutes along with prepare for all of my other subjects. In the end I tend to just take bits and pieces of the units. Last, there is no possible way for me to even come close to teaching the entire unit in the amount of time that I have the Science Kit. Just way to much material and lessons.

20. My Earth, Senses, Is It Living - the kindergarten students really enjoy these topics and they are developmentally appropriate.

- 21. Kindergarten should just have 2 science kits to complete and have each one for a longer amount of time. My Earth and Is it Living could be combined into one unit in the Spring and Senses could be in the fall. The concepts in Kindergarten in Motion could be integrated in math and other parts of the day.

School 3

- 20. As much as I hate beetles, I like the Organisms Have Character because the students love to be able to see and touch live creatures!
- 21. The assessments are too wordy, very overwhelming for my low readers, although they do cover the material, the questions just contain too much information.
- 20. Earth Land and water the hands on is great and students love it
- 21. The lessons sometimes take more than one day to complete and at times students forget from the day before.
- 20. Is it living...most interesting for students.
- 21. Doesn't match new common core
- 20. Organisms in Environment because of live animals, kids love for nature, food webs. Also, A view from Earth, kids love using models to understand seasons, day/night. Basically, the more hands on the better.
- 21. Not enough time to do a great job doing the lesson and journal work in the same day. Kids struggle with journaling concepts that are new. Perhaps a new format for journals would improve with checking for understanding with less open writing tasks

School 4

- 20. Earth Materials
- 21. I find I enrich the kits with literature I find on my own.
- 20. Sound and Light in Third Grade, engaging for students and circuits unit in 4th lots of hands activities and great lessons.
- 21. I would like to see more rigor and inquiry within units. Some kits have too much fluff, the first grade weather kit is terrible.

District B

School 1

- 21. Not used with fidelity in lower grades so there are holes in student knowledge when they reach upper grades
- 20. Plants the kids enjoy the activities; it seems developmentally appropriate
- 21. I have very little time to teach science. When I do, I need to trim lessons to fit into very short time periods. Help!

District C

School 1

- 20. 5 Senses because I can tie it in easily with my writing curriculum.
- 21. I love using the kits. I don't always use all the journal pages due to lack of time.
- 20. Forces and Motion. It is an interesting unit to the students and the experiments/demos are fun and interesting.
- 21. At the risk of sounding brusque, here are some of my concerns/impressions regarding Battle Creek science: 1. The lessons as written do not do a very good job of focusing on one "takeaway" point. They are too dense in many cases and seem to have been written by someone paid by the word. The pre-lesson discussions are pointless. KWL charts are pointless. There are far too many introductory steps to a demonstration. If a student knows something about the activity that will come out during the course of the activity. 2. The student journals are nearly useless. The writing prompts lack focus and do not catch a writer's attention. When students open to a page that is nothing but writing lines, and the prompt is something dry and uninteresting like "Write a concluding statement using your data about the force used to move the block up the ramp..." there is no student buy-in to that writing topic. I routinely change the prompt to reflect a little excitement and focus the writer's attention on a particular outcome I'm interested. The artwork is absurd and amateurish, which seems like a silly complaint but seems to project a feeling among my kids that the work is not very important. Asking students to create a graph from scratch without grid paper, free-hand, is too difficult. Providing a blank area of paper and asking kids to draw a graph makes for some pretty ugly graphs. 3. Many of the demonstrations are unreliable and involve far too many steps to justify the learning they are trying to convey. For example, the whole earth's axis model from Objects in the Sky, where the students have to somehow figure out how to tape a straw to a styrofoam cup, is onerous. We use bent paper clips and small balls of clay and provide a better model in one fifth the time and one tenth the frustration. 4. There are many lessons where student discussions are not set up to activate prior knowledge. For example, at the beginning of the Forces and Motion unit, students are asked to brainstorm a list of "motion words". Students have a very difficult time divining motion words out of the ether of their brains without any context. Instead, I ask the students to think about a marble, and describe a vacation that the marble might take. They

write for about fifteen minutes and often have really funny and interesting stories about where the marble went and what it did. The next day, I ask the student to highlight any words that have to do with a direction or location, then we highlight any words that have to do with distance or speed. The students have a fantastic vocabulary for motion words, but not unless they have what Battle Creek science might refer to as a point of reference. The marble provides that point of reference for their imaginations. 5. There are many online sources for animal observation where we don't have to have live animals in the classroom (per the Systems and Survival unit) that may or may not have a home afterward.

- 21. Our blocks of time required for ELA and Math have, while also incorporating Social Studies, decreased the available time for Science.
- 20. Light and Sound, Changes in Motion
- 21. Any unit with "Living Organisms" is difficult to teach and maintain. We have not had any luck with crayfish or grubs.

School 2

- 20. I enjoy the states of matter and organisms unit most. Both units seem more relatable to students and are therefore more engaging to them.
- 20. Organisms in Environment because of live animals, kids love for nature, food webs. Also, A view from Earth, kids love using models to understand seasons, day/night. Basically, the more hands on the better.
- 20. Forces and Motion- fifth grade. There are lots of fun experiments. Students make rollercoasters, hand design and make a spinning top, and a lot of marble experiments.
- 21. Our time to implement science has been cut down to basically half of the year. Even then, we don't have a full 45 minute time frame to complete the lesson. We get the experiments done, with discussion to support development and vocabulary. Some science journal pages are used, but there isn't time for students to do a lot of writing.
- 20. I enjoyed the simple machines which is no longer a part of second grade. The student enjoyed it and could grasp the concepts.
- 21. We do not have the time to teach the content given. Some of the content was shifted down from higher grades so it is too difficult for our students. Some of the material is very repetitive and the specimens don't provide the results expected.
- 20. Changes in Motion... The activities are fun, and the kids enjoy using the toys to learn about movement.
- 21. I wish the materials for each lesson were packaged together... Not just each unit.

Sometimes it takes a long time to dig through everything to find one little item.

- 20. Changes in motion- fun to play with the toys, fun to see toys in space
- 21. Getting all of the earth material samples prepared for students in Earth and Me is very time consuming. It is difficult to teach all 4 units in one school year.

School 3

- 20. Measuring Matters 2nd grade
- 21. Some of the materials are used year after year and not replaced. Some of the materials are cheap and break easily.
- 20. Have taught all the current units so not sure yet

West Ward Elementary – Allegan

- 20. Changes in Motion- I miss Solids, Liquids and Gases that we used to teach in 3rd grade
- 21. Changes in Motion- I miss Solids, Liquids and Gases that we used to teach in 3rd grade

District D

School 1

- 17. STEM in Macomb County this summer
- 20. I like the lessons about Newton because it's so relative to every day life.
- 21. It is next to impossible to make up lessons for absent students.

District E

School 1

- 21. We are required to focus on language arts and math. we have about 45 minutes 2-3 times a week available for science. It makes it very difficult to teach the units as they were intended.
- 20. My Earth—

- 20. Life Cycles, although I was sad to see that we are no longer using the Monarch Butterflies.
- 20. Organisms My students really enjoy the plants and live organisms.
- 20. Landforms
- 20. States of Matter. Very fun experiments for the students. Lessons are very well planned out to make sure that the concepts are learned.
- 20. Motion because there are a lot of fun experiments for students.
- 21. When moving from grade level to grade level, there isn't an opportunity to be trained in the new kit. Or I am unaware of the training.

School 2

- 20. too many to count---Matter Matters/Caretakers/Simple Machines w/ Legos
- 21. My biggest concern is that this district seems to think that Reading and Math are the only subjects to teach. Not to mention we are told to test all the time. Too many teachers are giving up teaching science because they are told to teach math and reading and put science and social studies on the "back burner". No one is checking to see if they are taught and too many turnovers in principal jobs and they are overwhelmed as well as the teachers and can't help monitor the teaching of kits.

School 3

- 21. I wish the students had more text to use to review with.
- 20. Light and sound
- 20. Forces and motion because my students enjoy the marble motion and roller coaster activities so much. The tops and the paper airplanes are very popular too.
- 21. Sometimes the set up is difficult and time consuming. The activities are sometimes repeated from one grade to another.

School 4

- 20. Weather watchers and butterflies
- 21. I need a new set of guides. I do not have paper to print these. Mine are 14 years

old.

School 5

- 20. Butterflies -monarchs, painted lady caterpillars are gross

School 6

- 20. I like the motion and force unit the most. The students can relate well to the concepts because they see they all have experiences with this topic of study.
- 21. I am very concerned that science kits have been put on the back burner in terms of instruction. The focus is reading and math and we have basically been told that these subject areas take precedent because if students can read, then they can read to learn about science. With all of the new curriculum in reading, and teachers having to differentiate instruction in both reading and math, our time is spent in planning for these areas. Science is pushed off due to not enough time during the day to teach it and not enough time for the teacher to plan effectively.

School 7

- 20. butterflies and simple machines when they were 2nd grade units
- 21. I love that everything is right there in the kit, I just don't always feel confident in teaching all the aspects of it. I started out teaching the previous second grade kits and received training. I then had to be trained for the new kits and then had to retrain on the new kits after teaching middle school for a couple of years. I really appreciated the second round of training on the new kits - I felt like I knew where to ask questions. I think this might be useful to others. Maybe a brief overview of how to use the unit when you first begin and then a more in-depth training after you have had a chance to use the kits a little.
- 20. light, sound, motion
- 21. Plants are overdone. By the time the kids have had a whole semester in 2nd grade, they are bored with it in 3rd grade.

School 8

- 20. 2ps measuring matters. The kids and I find the experiments very fun and interesting. I also like this best because the other two use dirt and sand so much it makes a mess of my room.

District F

School 1

- 20. Changes in Motion and Organisms Have Character, love the students playing with the toys and love the critters
- 21. Would like enough trade books or literature for the whole class to use or at least share with one other person (delivered in the kits) Not just 4 copies. I would like to see more critters, 3rd graders love watching them!

- 20. Forces of Motion. This one is fun because the activities are very active and hands-on.
- 21. The lessons take a lot longer than what they say in the Teacher's Edition. If a lesson says 1 day, I normally expect it to take 2 days to complete. In a perfect world, these lessons could be completed in the allotted time, but set-up, grouping, student behaviors, etc. can sometimes cause them to take a little bit longer.

- 20. All of them are fun!

- 20. it depends on the year. I like what the students get into.

- 17. SVSU Teaching Core Ideas in Science
- 20. Forces and Motion-the students love all of the experiments and gathering of data
- 21. Our district has purchased the kits. We get our kits now from the district with most of the materials in them. It's not enough. We have to supplement them with our own money if we want enough. Also, our district shortened the amount of time we had the most involved kit with (Forces and Motion) so we were rushed.

- 17. TCIS, Engineering is Elementary, NGSS

- 17. yes, SVSU presenter with Connie Kennedy
- 20. Animal Life- Butterfly experience is always enjoyed by all

School 2

- 20. An animals life An animals life
- 21. Always a need to supplement

- 20. Energy the students love it and Consumers Energy presenters are terrific to tie into the standards.

- 20. Weather, my students love learning about what is going on outside. My students also love learning about different weather storms around the world as well.
- 20. Energetic Connections and The Planet Rock are my favorites because my students get really excited about the lessons.
- 20. Animal Adaptions
- 21. We just need more time in our day to get everything done! :)
- 20. Weather Watchers

School 3

- 17. NGSS (I believe)
- 20. Butterfly unit (first grade) and the (old) meal worm unit because students could see a lot of changes and got to see creatures up-close. Also the Measuring Unit in second grade (currently.) Students like the experiments.
- 21. There is limited time for science, and some units are harder to follow. For instance, the lay-out of the Land and Water unit was not as easy to follow as the Measuring Matter unit. I do appreciate the science units though, especially since they go along with the Common Core.
- 20. 2nd grade measurement because it is very interactive.
- 21. It is kind of long visually unappealing to read.
- 20. Senses
- 21. There just is not enough time to complete the whole kit in the amount of time we have. Not with all the ELA and math objectives that are expected.

School 4

- 20. Weather, Plants and Animals, Water Cycle
- 20. Living Organisms, Motion

School 5

- 17. one 2 hour training, and one 2 hour question/answer training
- 20. I like the Systems and Survival unit the best. It has a lot of hands on applications that really help the kids.
- 21. The lessons aren't laid out in a user friendly manner in my opinion.

- 20. Habitats
- 21. The Binder is overwhelming. There is too much to cover in what little time we have. Student journals bore the students. I try to use my own interactive journal
- 20. Changes In Motion - a lot of inquiry based, hands on lessons that the kids get very excited about.
- 20. Earth Land and Water-- Students enjoy the activities-- especially building landforms.
- 20. Objects in the Sky, Tie the kit into field trips at the Planetarium
- 21. I believe each school should have all 3 kits at the same time. To use at their school for the year. Some experiments do not work out.
- 20. Plants - The students love watching and measuring their plants they grow starting from the seed. They take more ownership and responsibility.

School 6

- 20. I like all the units
- 21. The third grade Motion unit test has a question / answer that does not match the lesson taught and causes students to get the question wrong. It is a question is #3 "Roger and Mike wanted to record the motion of the jumping frogs. Choose the list of words for" Lesson #2 teaches motion words vs. direction vs. speed. According to lesson two, Journal answer key page six, none of the answer choices are correct.
- 20. All - each kit offers interesting investigations for my students.
- 20. plants--interest is high, the growth of the plants is visual, it is easy to integrate into other areas
- 21. as noted above, there are insufficient materials for one-to-one (and sometimes pairs or smaller groups) without the need to purchase-procure more
- 17. TCIS
- 20. sound/light
- 21. I wished there would be kit specific training. All of the training I've had through Battle Creek was a waste of time. They never took the kits out and went through experiments or ideas of how to engage or trouble shoot. It would have been awesome to do some of the experiments and let teachers feel comfortable with the kits. Explain a bit of what's in the kits and why.
- 21. We have one to three books with each kit in a class of 30 students. There are no textbooks to go along with the science units. Our district average is 19% proficient in 5th grade. What we are doing is not working, hasn't been working,

and won't continue to work with what we have. There has to be content delivered to the students before all of this inquiry based experiments can be understood.

School 7

- 17. District PD in Sept
- 20. An Animal's Life (first grade), very interesting & the kids love it!!!!
- 21. Enough materials and broken materials.
- 20. Is it Living
- 21. Need more in-depth training in each kit.

Mackensen – Bay City

- 20. Force and Motion: kid friendly and interesting

District G

School 1

- 17. living organisms
- 20. magnetism and electricity
- 20. Is it living and senses. The kids really relate to these. They are so excited about it.

District H

School 1

- 21. I do not feel that the Science kits are helping our students with State Assessments. Our scores are low! Plus as a teacher there is too much preparation for our lessons.
- 20. Plants
- 20. Forces and Motion in 5th Grade as it requires the students to think about how to alter the experiment to achieve outcomes.

District I

School 1

- 20. Changes in Motion - To me, this unit seems more relatable to the students than the others I've taught so far.
- 21. The prep work can be a bit overwhelming sometimes, but I see the value in the program.
- 20. Senses - There are several additional activities that correlate and it's simple to integrate in other subject areas. My students enjoy the experiments. The unit is simple to instruct and assess.
- 20. Earth science--I love the study of geology. This is our last unit, and I think it's my favorite not only because I enjoy geology so much but also because the kids are at such a higher level at this point in the year and are so much more self-sufficient in their reading, writing, and knowledge of the expectations.
- 21. It's a very time-consuming program. Sometimes lessons that should take two days, take me four. So much really depends on the writing/reading skill level of my students. I DO love how excited my students get about science with this program!
- 20. Senses - There are several additional activities that correlate and it's simple to integrate in other subject areas. My students enjoy the experiments. The unit is simple to instruct and assess.
- 20. I really like the Light and Sound Unit because the activities are fun and engaging for the kids. The investigations are a little easier to put together for the teacher.
- 21. I am mostly concerned about the transition to the Next Generation Standards. I am in charge of science at the school and I'm concerned about exchanging materials and being sure resources are at grade level.
- 20. Getting all of the earth material samples prepared for students in Earth and Me.
- 21. The Organisms in Their Environment unit has posed some issues in my grade level due to the up keep of the animals. My team has decided not to use this portion because the murky water made it difficult for the students to even observe the animals. It was more of a distraction in the classroom than a learning tool. very time consuming. It is difficult to teach all 4 units in one school year.

District J

School 1

- 20. 5 senses and living non-living are my favorite because they are very age appropriate! The kids have more connections to these units and score higher. They are more concrete than motion & earth units. But I do love that those units address misconceptions; like the sun moves.
- 21. Only concern is teaching 5 year olds how to take test. The assessments are NOT accurate measurements of what they know because of the test taking skills; tracking left to right, crossing out some pictures circling others. It test their ability to follow multiple step directions, track left to right top to bottom, using a pencil, staying tuned in/attention span
- 20. An Animals Life- Students love it.
- 21. Lessons are VERY long and wordy- feels overwhelming to implement. Also expected time frame for lessons is not practical- too long.
- 21. I find the assessments to be an inaccurate representation of what my kids know. The assessment only tells me if my students can follow directions and take a test. It does not tell me what they truly know about the concepts.

School 2

- 20. Energy Transfer - the students are very engaged and active :)
- 20. States of Matter & Organisms in their Environment - very essential for life, hands on, and fun! Filled with "ah-ha" moments and connections.
- 21. "View from the Earth" is EXTREMELY confusing to the students, and difficult to teach. We have not in any way received ANY P.D. on our kits/units/curriculum.

School 3

- 17. All for grades 5,6
- 21. I do not believe the program, at least in grades 5-6, contains the depth of knowledge or content needed.
- 20. Energetic Connections is a fun unit to teach due to the high student interest in flying/rolling/moving/falling objects :)
- 21. I've found minimal value in the student journals as they often just provide spaces or lines for the students to jot down notes or create graphs/data tables (something that can be done in their own notebooks). While tradebooks help give context and real world connections to investigations, there is a glaring lack of grade-level informational text. As we know, being able to read informational text and interpret data tables, graphs and infographics is a critical skill required in the science portion

of standardized tests. In the past my building has supplemented each unit with textbooks, newspaper/internet articles, etc.

School 4

- 20. Earth Materials- gives students science content as well as knowledge about earth care (recycling, etc).
- 21. The materials set up and clean-up takes a long time. The science journals are very heavy on writing for students who are not yet reading at grade level.
- 20. Earth and Me/Living Organisms- They both are really exciting to teach because the students are constantly engaged in the material.
- 21. I find that I have to spend a lot of time prepping my students for the summative assessments in order for them to do well. They just aren't ready after each unit is completed.
- 20. A Plant's Life
- 21. Some of the lessons are redundant. Overall, great program.

District K

School 1

- 20. The Planet Rock is extremely engaging to students.
- 21. I wish the pre-writing strategies were listed within the lesson (where the journal work is listed) because I forget about them since I am not looking at the back of the lesson page. The website links need to be updated - I have found several that no longer work. I generally just google the topic at that point. Not sure what industrial journals are so I answered that question assuming they were the student journals.

District L

School 1

- 20. I like the Earth and Me unit because I enjoy Earth science. The kids also like touching the materials that we receive from the science center.
- 21. I enjoy the kits, and advocate for us to keep the time that we have to teach them. I rarely have a full hour to teach science, so I am usually picking the most important parts of each lesson to focus on. I feel that the summative assessments are a little difficult for my grade level. I look forward to science

each day because it is a great chance for my students to experience the world around them through the lessons that your center has created.

- 20. Plants, the experiments are quicker and students can complete the unit fairly quickly.
- 21. The hard part of using the experiment based units are the results sometimes alter students understanding. It never fails that the plant potted in soil reviewing sunlight never sprouts, but the plant right next to it in the sand does. Or not one seed in the baggie seed garden sprouted to show roots. So then, I have disappointed students and have wasted a whole day making them and hanging them in Windows.

School 2

- 20. seasons
- 21. We don't have enough time to teach them
- 20. Sound and light
- 21. Lack of time and buy in of use by teachers and school compared to when it was at Battle Creek Public
- 20. The life cycles, the kids love watching the butterflies grow and change!
- 21. The lessons are too lengthy and our schedule doesn't allow for enough time to even come close to teaching the lesson in its entirety, let alone teach science period.

School 3

- 20. Forces and Motion It has a lot of hands on activities.
- 21. The kits have too much in them. I don't have time for all the experiments.
- 20. Force and Motion
- 21. I feel like the Science Units are very time consuming and they are hard to use in the short amount of time we have to teach the unit.
- 20. The Planet Rock - most enjoyable and most interesting to the students.
- 21. Kits have too much 'stuff' in them - our science standards don't cover all that is in each unit and so there is a lot of extra lessons that don't get taught.
- 20. Objects in Motion 5th grade- my students really learned a lot
- 20. I like them all electricity is my favorite activity.
- 21. The programs are good and Coldwater showed good growth using them until

they cut the time to teach science in K-3 to nothing.

District M

School 1

- 17. Next gen science training in Mt. Pleasant, Michigan
- 20. I love the physical science units! The students enjoy the experiments.
- 21. 7th grade needs a life science unit. The life science units in 5th and 6th grade need more substance. There is a lot of observation and not much hands on once the animals are in the tank. (But the students LOVE the Anole lizards and Tree Frogs!) The wood beetles and millipedes disappear into the soil and the students barely ever see them. In fifth grade, the hermit crabs don't move around much during the day. Overall, I love your program! Thank you for all you do!

District N

School 1

- 20. Earth's land and Water
- 20. Earth's land and Water
- 20. Animal and Plant units
- 21. I had to leave one section blank because I couldn't answer the questions. Also, I am new to teaching second grade after teaching kindergarten and have not been to any new training. I'm not sure I should because I will be retiring in 2017. The other 2nd grade teachers have been very helpful.
- 20. Objects in the Sky- the students are very interested in space, there are a lot of fun concepts in the unit that the kids are curious about.
- 21. I don't have anywhere near enough time to finish the lessons in each unit; the number of questions on the summative assessment for each concept don't always match the amount of time spent on the concept during the lessons
- 20. Earth
- 21. I still receive VHS tapes. We no longer have that "old" technology. No way to play them. I highly dislike that we have to input each students answer (a, b, c, d) for every questions because (we were told) BCMSC uses this data to improve the kits. I have never seen a kit changed because of the data I enter. All other scores we enter by points. either right or wrong. To much time taken away to do the a, b, c, d!!!

- 20. life science first grade
- 21. I think that the kits are outdated, they should have digital books, experiments that can be done on ipads/chromebooks, videos, extended learning opportunities, book lists for kids that want to learn more. I feel like the excitement happens when they get to interact and I think it would be great for them to have special links to great apps or websites that would inspire more learning.

School 2

- 20. objects in the sky
- 21. The person who keeps track of the kits is not very friendly if we have questions
- 20. Have only taught one, so I don't know.
- 21. I am a special education teacher teaching cognitively impaired 8th grade students at the 3rd grade level. I have not been trained in anything involving science or the science kits. I also do not see the growth that the general education teacher would hopefully see.

District O

School 1

- 20. Energetic Connections - students love the building and thinking involved with creating their own rollercoaster
- 21. My comments are that the teacher guides are hard to slog through and are overwhelming----- the lack of drawings, pictures, illustrations...very bland. There are a lot of science lessons, but the time I have to do science has decreased significantly. I have to pick and choose lessons, or significantly shorten time for lessons. A streamlining suggestion would be awesome, although may not be conducive with your ideas of the best use of your program. Having an online component would be excellent with links, videos, etc., in a centralized location. The tests are huge and there are no already created formative or summative quizzes that I have seen (are they updated on the website with the newest test versions?) The website where items are located is hit or miss with me. It works sometimes, not others, finding what I want is difficult/time consuming. It would be awesome if you had examples texts of student responses that work for the student log and/or for the assessment. The Science that we teach at this level does not really, at this point, seem to match well with the math that I teach at this level. Very hard to integrate the math and science at this level with the topics covered in both.
- 17. Some of the lessons are redundant. Overall, great program.

- 17. STEM PD at the WISD
- 20. Objects in the Sky because the children love learning about space and the models that are available are fun for the kids to use and help the kids develop a strong understanding of the expected outcomes.
- 21. I would love to see a more "interactive" notebook approach. I feel as though this would allow the children to incorporate more writing and a stronger understanding of the concepts. Graph paper added to the journal would be ideal. Better artwork in the journal would be great as well. More STEM related activities would be so engaging for the kids. The teacher guide is not well organized. I would love to see the organization reworked so that it flows easier.
- 20. Energy. I just like the energy unit.
- 20. Systems and Survival and Forces and Motion I have a love of both of these topics. The F and M unit is fantastic to teach team work and there is always a hands on activity to teach the concept.
- 21. We are no longer interested in purchasing animals for the small amount of time that they are used. We would rather use species that are native to our area so that they can be released once the school year is over.
- 20. solar system
- 21. materials are not quality, cheap construction or they break too easily. Journal assignments are not always clear, need more reading integration
- 21. There are too many gaps in the learning between the concepts and the labs. I have to fill in those gaps. A new teacher cannot just pick up those kits and use them. The labs take an extended time to set up. Many of the labs repeat from year to year but the level of complexity does not increase.
- 20. Energetic Connections- The students enjoyed this one the most
- 21. I would like to attend professional development for the program

School 2

- 20. Weather
- 21. The Battle Creek Science program lacks inquiry base learning that is engaging and allows for in depth deep scientific thinking. These science units are not exciting enough for my students. The experiments are weak and lack excitement. They do not align to the CCSS. I usually read over the science units and tweak them. I make the experiment more engaging and More indepth for the students. I have created more engaging journals that allow the students to write in depth about their scientific findings.

School 3

- 20. Electricity - Kids love making circuits
- 21. Materials are often poor quality, especially in the electricity unit. Better made battery holders and clips would be very much appreciated. They are hard for little fingers to manipulate.

School 4

- 20. landforms/water- It has a social studies element which I enjoy. I really like earth science and it is easy for me to transmit that to the students.
- 21. With Common Core having some online our time for teaching science has gone way down. We have asked to integrate more into literature. The time expenditure for BC science is just not possible. Even when we did have more time, the time spent teaching every lesson the way it was written was too much. It is also NOT a teacher friendly program. I understand the science behind it, but it takes a lot of time to prep both for the materials and the concepts to be taught.

School 5

- 20. Landforms with sand

District P

School 1

- 20. Energy transfer- very fun
- 20. Systems and Survival in 5th grade. This unit seemed to stick with the students the best out of the other 3 that we learned last year. It was very easy to create outside projects to help supplement this unit as well.
- 20. Earth Land and Water. I like this unit because it has a lot of hands on activities that the students can connect with.
- 20. Energetic Connections and The Planet Rock are my favorites because my students get really excited about the lessons.

District Q

School 1

- 17. Van Andel Institute
- 20. States of Matter, View of the Earth, Energy Transfer
- 17. Van Andel Science Institute
- 20. I love the planet rock and earth science units. They fit so well together and are exciting to kids!
- 21. My only concern is that the lessons are too wordy. Not all of the information is relevant and I think it could be organized to be read more easily for teachers.
- 20. weather
- 20. weather

District R

School 1

- 20. I enjoy the Heat Transfer Unit. It is very engaging for the students and I have been very successful with the investigations.
- 21. I would like more formative assessments embedded into the units. I would like progress check points and study guides leading up to the summative assessment.
- 20. Forces in Motion
- 21. Would love to see more technology based lessons.....

School 2

- 20. Forces in Motion
- 21. Would love to see more technology based lessons...

District S

School 1

- 17. MEMTA in Jersey City, New Jersey last year-1 week
- 21. I find that, as a teacher, I understand how to put the lessons together and to choose which activities and components to use with my students. What I find I need more support with are the actual science concepts and how to best connect the learning across the lessons to build student understanding of those concepts as effectively as I can. This is only my second year teaching science and using these kits, so my knowledge base and experience is growing exponentially. This has been my observation for my own experience given what I am bringing with me to the classroom.

School 2

- 20. My favorite units are the physical science units. I love how hands on they are and how clear the expectations are for what the students are supposed to be learning.
- 21. The 2nd grade unit on Measuring is very close to what our students do in our Math program, so I find it to be very repetitive.

District T

School 1

- 17. NGSS training
- 20. Earth: Yesterday, Today, and Tomorrow; great activities for the kids and ones the students like to keep working on when they leave the class.
- 21. 6th grade sometimes it seems tough to get through certain kits. 5th grade some test questions might need to be looked into.
- 20. Life Cycles-habitats, Making the Boat in Sorting things out.

District U

School 1

- 17. Kellogg Bird Sanctuary K-12 teacher training
- 20. Living/Non-Living because students interact with worms/butterflies
- 17. Kellogg Bird Sanctuary K-12 teacher training
- 20. Living/Non-Living because students interact with worms/butterflies

20. land forms

20. I have enjoyed the live organism units, because the students get more excited about them.
21. It has been extremely difficult to fit every part of the science kit units into the time we are given each week. It does not line up great with the math and literacy units that we are teaching at the time so it has been difficult to incorporate science into part of the math and language arts time. I don't have the time to always make the copies of the word sort cards, and it would be helpful if they could be part of the science kits. I think they may help my first graders to do better on some of the writing portions of the science journal. I feel that I have to rush through so much of the kit, and I don't enjoy them as much as I think I should and my students should. In one of my last training sessions the instructor had something similar to a lesson plan for lesson one of the unit. It pulled out some of the most important pieces of the lesson to make it easier to plan. If those were something that was provided with the kit I think I would be able to get more of the lessons in within a comfortable time period.
20. I do not have a favorite yet.
21. The investigations are great. The students are engaged and like working with and learning from the materials. However, I adjust most of the investigations to match the summative assessment. The goal of the investigation doesn't always match what is being assessed.

School 2

20. My students and I really enjoyed the living things unit (butterflies). All of our caterpillars turned into butterflies, and my whole class got to watch one caterpillar shed its skin and turn into a chrysalis. It was a VERY magical moment for them! I have never seen so many kids be so excited about science.
21. It would be helpful if the kits came with a new teacher journal each time so that you can use it with your students. The previous teacher kept her filled out journal with the binders, but it makes it hard to do it as a class with all of the material already filled out.
20. Weather
20. Senses: the students love it. I can use it in a lot of different subject areas and find different activities
20. I enjoy all four K units!
21. Please update the summative assessments.
21. Machines movement

- 20. I enjoy teaching the Earth Science unit for 2nd grade. I like to see the students get excited about their world and how it works. I've also enjoyed teaching the Life Science unit (which is now 1st grade) with the butterflies. It is a lot of fun to teach and the children really enjoy it!
- 21. I feel that the plants unit for 2nd grade is very "boring." I find that my students already have a great deal of knowledge about plants and their needs that the unit is very redundant for them. I still teach it, but there is definitely less engagement because the material is mostly a review from previous years' learning about plants.

School 3

- 20. Senses
- 20. This year I liked the plant unit the best.
- 21. Due to district mandated time for ELA and math, I am not left with a whole lot to teach everything in the science kits. I find myself "cramming it in."
- 20. Living Things (kid's love it), Liquids, Solids, & Gases (great experiments)
- 21. For Kindergarten and some of the kits in 1st grade are very difficult for the children to complete the writing portion of the journals. In kindergarten the kindergartners cannot read the journals.
- 20. Organisms- kids love live animals

School 4

- 20. Weather, lots of fun investigations.
- 21. The length of the writing expectations in the journals is sometimes too much for first grade abilities.
- 20. I loved the first grade unit when we had Monarchs!
- 20. I love them all but I especially love Light and Sound. It has engaging lessons and the students are very interested in the content.
- 21. No concerns. Love the program!
- 20. Senses... Kids love it. Fun.
- 21. I hate the worms. They die and stink up my room. Hate them!!!!
- 20. Organisms in Their Environment is my favorite 4th grade unit because I love the critters and the students get really excited about the living organisms.

School 5

20. 3rd Grade Forces and Motion-Students are getting their first taste of simple machines and the power that they can give people. They are very excited to learn in this unit. 5th grade-Objects in the sky, because it is very interesting to the students the thought of unknown places, and they get to greatly build on their knowledge gained from 4th grade material already filled out.
 21. I think it would be good to be retrained in the science kits that I am currently teaching. With that being said, the reason I didn't is because the trainings I have attended have been inconsistent in the past. Some very worthwhile and helpful, practicing experiments and going through activities, others rushing through and offering little more than a read through of the material I felt like.
20. 5th grade Earth Science

District V

School 1

20. Earth and me and Organisms have Character. Because those are both areas of interest to me and I feel more comfortable in my knowledge when I am teaching those units.
 21. I don't like the choices in organisms for Organisms have Character. Every year the crayfish all die pretty quickly. And the beetles are just not interesting. They hide all of the time. They typically all die as well. I feel like there must be organisms that the students could more closely relate to that would actually live through the whole process.
17. Rock star technology camp Sagatuck, MI July 2015
20. I love the energetic connections kinetic and potential energy kits... There are a lot o hands on activities that are not time for training
 21. For 6,7th grade the lessons take at least a day to two day longer to get through. My Science periods are only 50 min. Long. After intro concept and vocabulary not enough time to complete activity in same day. A little disconnected. The marking periods are 7-8 weeks... It is always difficult to finish units on time. There are many interruptions at schools. I teach 6-8 Science... I love the subject and kits. I think people with non science backgrounds struggle with the significance of the kits and Science in general . I hope your project turn out., I would love to read results.
20. Monarch Butterfly kit (former second grade kit), Flowering Plants kit, Simple Machines kit (formerly second grade)
 21. The second grade earth science kit should be split into two. A semester is an unreasonable amount of time for one kit. Maybe a kit about landforms and a kit

about water, with two separate assessments. They could even be delivered at the same time.

- 20. 2nd grade light, 2nd/1st life cycles--both very engaging for the students.
- 21. The 1st grade weather unit does not contain any lessons about the water cycle...seems like a necessary understanding as we talk about precipitation. I've supplemented with my own fabulous lessons, and when I have my students do much better with understanding clouds & precipitation

District W

School 1

- 20. Plant Life Cycle
- 21. My district places no importance on time available to teach science. It is worked into the teaching schedules when it can be done
- 20. The old Electricity and Magnetism - thought it covered and made the connections more clear than the current Energy Transfers does. More in depth and application of Electricity in the old kit
- 21. Wish we could have them up and running with the Next Generation Standards for next year. I love these kits and so do the kids. They leave my room loving science and are fully engaged in the lessons the big question always comes down to why the entire State of Michigan can't seem to do well on the standardized science test. Perhaps someone should analyze the test and not the kits!
- 20. Organisms - the Bess beetles and the crayfish are favorites of the kids. Also, when we did Monarch butterflies in 1st grade the kids loved all of those lessons.
- 20. Force and Motion Lots of math and great activities

School 2

- 20. Seasons: Many kids don't know the seasons; senses and is it living
- 21. I don't like the choices in organisms for Organisms have Character. Every year the crayfish all die pretty quickly. And the beetles are just not interesting. They hide all of the time. They typically all die as well. I feel like there must be organisms that the students could more closely relate to that would actually live through the whole process.
- 20. Force and Motion - the students get totally involved in the activities and are able

to take what they learn and apply it to outside interests.

- 21. Due to the focus on reading and writing, science time is taken a hit.
- 20. I have only taught first grade science kits.
- 21. Very time consuming... Not always age-appropriate (above grade level)

School 3

- 20. Living things: makes sense to k students
- 21. The student journals are not necessary at kindergarten level. They are not developmentally appropriate and they are redundant.
- 20. Light and Sound for 3rd grade. I love the experiments and the kids get excited about already knowing something about this topic and being able to add on to what they already know!
- 21. Unfortunately, it is very difficult to get through each lesson of every kit in the time that I have the kit. This is my biggest concern.
- 20. Earth's Land and Water...It is very hands on and the kids love it!

District X

School 1

- 20. Light and Sound, Measuring Matters
- 21. The summative assessment is very lengthy at this age it would be helpful to break it up a bit.
- 20. Force and motion
- 21. Our Objects in the sky unit is too similar to the 4th grade unit.
- 20. Electricity and Magnetism: The experiments are fun, and my understanding of the content is good.
- 21. The science kits/journals need to be updated to match changes in state requirements.
- 20. Energy Transfer-The kids love the investigations.
- 21. I do think the kits need updating because I don't feel they meet Next Gen Sci Standards.
- 20. The Forces and Motion unit has a great deal of hands-on experiments for the kids to do which helps increase their understanding of the material.
- 21. It would be great if more lessons involved the use of technology & engineering.

21. 1. The lessons are written by people with a science background for people that have a science background. Most of us that teach the kits do not have a science degree. The lessons assume the teacher knows way more than we do about the topic. The lessons should be written by teachers. A first year teacher should be able to read through the lesson and teach it, rather than read it and have to search online to get the background knowledge necessary to teach the concept. 2. The lessons contain questions to ask the children, but doesn't have the correct answer for the teacher. 3. Third grade began receiving bess beetles several years ago yet we got ZERO text/materials to go along with them to teach ourselves or teach the children. The beetles have died by day two every year. Why would we be given an organism to observe with no supplemental materials? I have had to write my own unit around the bess beetles which I shouldn't have had to do. 4. Research is showing that kids are not able to read a science textbook in high school and college. We need more text! We need more picture books, articles, websites, etc. for these kids. We need sources that students can compare/contrast, cite evidence, note text structures and features, etc. These resources need to be grade level appropriate.
20. solid, liquids and gas; Flowering Plants
20. Life Cycles
21. They need to be updated to match Common Core. Assessments need to be changed to be grade level reading and more directly match the kit experiments.

School 2

20. I loved the Organisms unit in First grade when we had snails and beetles. The kids took deep ownership in those units.
21. There is just no time to teach the lessons. We are down to about 35 minutes, three to four times per week and that is not enough to cover the amount of material. We don't feel we have any way around this either. The kids enjoy the experiments but some of the more involved ones end up being taught as a whole group model because of time constraints.
20. five senses
20. Life science, opportunities to observe on a daily basis
21. Love the lessons and units, but I need more time in the day!

School 3

20. Plant Life and an old first grade unit on what floats
21. Science Journal writing expectations are a bit high for Kindergarten.

- 20. Senses--I have found that it is a solid foundation for the rest of the units.
- 21. I would strongly suggest a change in the writing journals for the kindergarten students, who are ones that struggle with formation of words or letters for actual writing pieces.
- 20. butterfly unit in First
- 20. Animals
- 21. Love them. So easy.
- 20. Plant Life

District Y

School 1

- 20. A View From the Earth or Objects in the Sky as the material interests me.

District Z

School 1

- 20. 4ES and 4PS1--I find them very interesting and my students tend to find these topics intriguing as well.
- 21. My only concern is that I find the allotted time frames to complete the lessons aren't long enough; it usually always takes me (and the students) longer to complete the lessons.
- 20. The students are always really excited about My Earth. They show such enthusiasm about the earth materials, I think because the materials are things they can encounter on a daily basis. I love teaching the unit on Senses because the activities are fun and engaging for students.
- 21. I am concerned, from a developmental standpoint, at how much writing is expected for the Kindergarten units in the science journals. As an end of the year expectation, it is appropriate. However, the amount of writing they do in the science journals for the beginning of the year is astounding and causes a lot of frustration for students.
- 20. Kdg. and 1st grade Life Science- relevant and relatable to student's lives. Also, great ways to connect with language arts teachings.
- 21. Time- There is so much pressure to get first graders reading and writing. Expectations are getting higher while student's skills seem lower. Therefore

more time to teach reading and writing cuts into science instruction time.

17. Dexter
20. "5 Senses" - students love tasting and smelling. "Living or Non-Living" – students love worms as a classroom pet.
21. "Kindergarten in Motion" - the toilet paper tubes are too small in diameter for most of the balls to go through. Every year, balls get stuck. Also, one lesson has 3 journal pages. This is too much for little ones. One journal page or activity each day is perfect. "Living or Non Living" - It is very difficult for students to think of experiments to do with worms. They don't have enough experience to come up with their own experiments. Giving them two or three choices is better. That is what I end up having to do every year.
20. Butterflies - students enjoyed it.
20. Organisms in Their Environment is my favorite 4th grade unit because I love the critters and the students get really excited about the living organisms.
20. 3PS - Solids, Liquids, Gases This is no longer a 3rd grade unit but I loved the Mission Impossible experiment. Students had to figure out a way to separate waste from a toy company. The mixture was marbles, styrofoam, buttons, sand, and salt. They used the tools they had been using throughout the kit. They figure out how to use separate the sand and the salt.
21. Prior to the kits, we did very little science. However, we did a lot of Social Studies. Since starting the kits, we do a lot more science and very little Social Studies. The biggest problem is loss of instructional time. There are so many things going on that create this loss. I'm also wondering how well the kits have been field tested. The directions don't always work. For example, the measurements for filling the terrariums in the 3LS kit don't work. The boxes with the tubes in the Light and Sound kit don't always work. The time frames for lessons aren't realistic.
20. I enjoy the Earth and Me unit because it allows the students to explore the earth and things that they are in contact with everyday. It is open to many experiments that they can do outside of the classroom.
21. The lessons seem to take a great amount of time.
20. earth's land/water
21. The lessons are long and require significant time to plan.
20. Animals Life - love watching butterflies
20. Senses because the kids are so engaged in all of the activities and I can add so many additional experiments of my own!

School 2

- 20. Probably the Objects in the Sky unit. The kids come up with many great inquiry questions.
- 21. My class this year is half special education students that are way below grade level in both reading and math. Implementation of the kits has been difficult this year as I am trying to adjust to teaching to these students' levels as well the other half of my class. I have also taught the same thing for so long with about the same results (our entire state struggles in science according to state testing data) that some new ideas would be welcomed.
- 20. I don't have a favorite
- 20. Objects in the Sky because the kids seem to have a keen interest in this unit and the activities involved.
- 20. 6th grade ES--I liked the earthquake activity.
- 21. The material is redundant and bores the students. In the 5th PS kit, several of the activities could be done once, instead of repeated several times.
- 20. Energetic Connections - I enjoy the activities.

District AA

School 1

- 20. Life Science because kids love learning about the world around them and it's easy to implement across the curriculum
- 21. The length of time it takes to read through the lesson plans is astronomical. The TE is not user friendly.

School 1

- 20. View from Earth - Earth's land and water