2019

Investigating the Improvement in Science Achievement Among Fifth Grade Science Students When Using the Instructional Design Model

Kisha J. Jarrett

Investigating the Improvement in Science Achievement Among Fifth Grade Science Students When Using the Instructional Design Model

by
Kisha Jarrett

An Applied Dissertation Submitted to the
Abraham S. Fischler College of Education
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Education

Nova Southeastern University
2019

Approval Page

This applied dissertation was submitted by Kisha Jarrett under the direction of the persons listed below. It was submitted to the Abraham S. Fischler College of Education and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova Southeastern University.

Robert Rose, PhD
Committee Chair

Vanaja Nethi, PhD
Committee Member

Kimberly Durham, PsyD
Dean

Statement of Original Work

I declare the following:

I have read the Code of Student Conduct and Academic Responsibility as described in the *Student Handbook* of Nova Southeastern University. This applied dissertation represents my original work, except where I have acknowledged the ideas, words, or material of other authors.

Where another author's ideas have been presented in this applied dissertation, I have acknowledged the author's ideas by citing them in the required style.

Where another author's words have been presented in this applied dissertation, I have acknowledged the author's words by using appropriate quotation devices and citations in the required style.

I have obtained permission from the author or publisher—in accordance with the required guidelines—to include any copyrighted material (e.g., tables, figures, survey instruments, large portions of text) in this applied dissertation manuscript.

*Kisha Jarrett*_________________
Name

April 24, 2019________________
Date

Abstract

Investigating the Improvement in Science Achievement Among Fifth Grade Science Students When Using the Instructional Design Model. Kisha Jarrett, 2019: Applied Dissertation, Nova Southeastern University, Abraham S. Fischler College of Education and Human Services. Keywords: science achievement, Instructional Design Model, teacher perceptions, elementary science

The purpose of this study is to determine if the Instructional Design Model will improve science achievement. The study addressed the problem of low science achievement among 93 Grade 5 students. The theoretical framework that was applied to this study was developed by Ralph Tyler in 1949. The researcher believed that Tyler's four-process curriculum planning approach guided teachers to look differently at teaching and learning. This model assisted teachers in developing lessons that used the Instructional Design Model and produced objectives that reflect their classroom goals, impacted curriculum, and increased the understanding of science concepts.

The school administered a multiple choice, twenty-item pretest a unit of instruction to the Grade 5 students. The teachers participated in a pre-interview, received professional development on the Instructional Design Model, attended common planning meetings to develop lessons, delivered the lessons, and participated in a post-interview. The teachers taught a four-week unit and each teacher was observed every other week for one class period. After the four-week period the teacher administered the posttest to the students; which, was the same test as the pretest to the Grade 5 students. A convergent mixed methods design was used; in order to collect data in this type of design, the qualitative and quantitative data were collected in a lateral fashion, analyzed separately, and then merged together.

An analysis of the data revealed the degree to which the use of Tyler's Instructional Design Model in Grade 5 science classes in the target district would affect student achievement in science. The results of the elementary school's scores were compared to the pre and post assessment data and determined that use of the Instructional Design Model significantly impacted post-test results.

Table of Contents

Chapter 1: Introduction

Statement of the Problem

The problem addressed in this study is that it is not known to what extent the lack of foundational concepts in science prevent children from achieving high scores in the 5th grade as measured by the school district's common assessment (CA). As a result, many students are leaving primary and secondary school without understanding fundamental science concepts (Blank, 2013). Researchers believe that a more defined model of planning, teaching, and assessing students is needed to increase science achievement (Ababneh Al-Tweissi & Abulibdeh, 2016; Cullen, Akerson, & Hanson, 2010; Tatar, Tuysuz, Tosun, & Ilhan, 2016; Taylor, Roth, Wilson, Stuhlsatz, & Tipson, 2017). Talanquer, Tomanek, and Novodvorsky (2013) expressed that engaging students creates opportunities, hands-on labs, and science-specific activities that produce and subsequently evaluate scientific explanations.

However, creating hands-on labs and science specific activities poses a challenge for teachers in the elementary schools. Ross and Carier (2015) argued that teachers struggle with "designing and planning rigorous lessons that provide students with opportunities to learn the necessary science content as well as participate in the science practices" (p. 574). The researchers concluded that the goal of science education is to provide knowledge beyond simple theories and concepts by utilizing hands-on activities that give the students an array of tools and paradigms. However, teachers only allow students to watch demonstrations; therefore, they are not having hands on-experiences. This lack of experience tends to result in lower science achievement scores (House, 2012).

Since 1994, there has been a national decline regarding the time spent on the subject of science (Blank, 2012). The author pointed out that, since trend data on the measure began to be collected in 1988, the national average of hours spent on elementary science instruction per week is at its lowest number despite the increase in instructional time spent on reading and mathematics. In 2003, the National Center for Education and Statistics reported that "measuring student progress toward attaining the goals defined by content and performance standards is central to standards-based reform efforts" (p. 11). These standardized tests were the focus of much attention during the 20th century. However, there has been little change during the 21st century since low science achievement among Grade 5 students in Florida continues to be reflected by the 2017 Florida statewide science assessment. Appleton and Kindt (2002), Blank (2012), and Kaezmpour (2013) agreed that despite the reform and the call to action regarding the importance of science, there is still a great need for student-centered lessons with hands-on activities rather than a teacher-centered curriculum. Blank (2012) explained that teachers should use various modes of presentation to accommodate different learning styles; this allows for students to learn collaboration and model inquiry skills in an effort to support science knowledge development.

Florida statewide science achievement data is reported below for two local schools and overall state (see Table 1; Florida standards assessment statewide science assessment, 2017). In Florida during 2017, local school A indicated that 28% of their local Grade 5 students were proficient (satisfactory performance), performing 23 percentage points lower than the state average. Science results from local school A and local B indicated that 71% of the Grade 5 students tested did not meet proficiency requirements on the FCAT 2.0 in spring of 2017.

Table 1

Grade 5 Science Achievement Scores, 2007-2017

School Year	Local School A		Local School B		State of Florida	
	# Students	%Proficient	# Students	%Proficient	# Students	%Proficient
2007-2008	144	14	108	18	194,991	43
2008-2009	114	23	99	24	191,751	46
2009-2010	82	29	115	20	196,011	49
2010-2011	115	23	101	17	197,657	51
2011-2012	121	31	111	45	199, 164	51
2012-2013	107	39	106	32	195,131	53
2013-2014	114	34	121	39	195,645	54
2014-2015	94	20	127	24	198,519	53
2015-2016	84	24	133	18	202,655	51
2016-2017	111	29	114	29	212,952	51

The topic. The topic for this proposed study is low science achievement for elementary age students. When students' development of scientific knowledge is low, exposing them to critical-thinking science activities based on empirical evidence and scientific literacy would be beneficial. This assists in creating a science-based learning environment (Blank, 2013; Panasan & Nuangchalern, 2010). The application of Tyler's (1902-1994) four-step model, a cognitive learning theory with a learner-centered approach that generates objectives, selecting activities, organizing and sequencing activities, and evaluation, will assist in the determination of success (Denham, 2002). Denham pointed out that Tyler was interested in how a student learned in relation to the issues of society and believed that contemporary life provided information for learning objectives. Therefore, in order for students to meet their goals in science achievement, they must understand the concepts and apply those concepts. In understanding students' learning and success, teachers have to be equipped with the appropriate tools to teach and evaluate student outcomes and how they align to the objectives. The research topic will expand on the prior studies by analyzing a district's standardized assessments for the students who receive science instruction.

The research problem. The specific problem to be addressed in this study is the low science achievement of Grade 5 students in an inner-city area of Florida. The state mandates that science be taught in elementary school; however, no mandates exist regarding the 120 minutes per week allocation of time given to science or how it is to be taught. The state government mandates that science be tested one time in Grade 3 through Grade 5 and Grade 5 students must be tested on three years of science concepts.

In Florida, students are not assessed in science statewide until Grade 5 when students take the Next Generation Sunshine State Standards Florida Comprehensive Assessment Test 2.0 (FCAT 2.0). The Grade 5 students are assessed on Grade 3, Grade 4, and Grade 5 standards. Science results are reported in three ways: by scale scores, content area scores, and achievement levels. For this study, the researcher will only analyze the achievement-level results. Achievement levels range from 1 as the lowest to 5 as the highest. A Level 3 indicates a satisfactory level of success, Level 4 indicates an above average level of success, and Level 5 indicates mastery of the most challenging content of the Next Generation Sunshine State Standards (Achievement Levels, 2014). Therefore, satisfactory performance would be defined as Levels 3 through 5 (Florida Department of Education, 2014c).

In 2013, the Florida Department of State implemented Rule 6A-1.099811 Florida Administrative Code Differentiated Accountability State System of School Improvement. Under this rule, if the elementary school is under Differentiated Accountability (DA) advisement, then personnel are required to administer progress monitoring assessments throughout the year. Florida's DA Program includes schools that have received a school grade of D or F and schools remain in the program for one year. In 2018, the Florida Department of Education Office of School Improvement reported that DA supports are intended to build capacity by focusing on systems and structures needed to improve and maintain school improvement by employing a gradual release model. In 2013, the Florida Department of State reported in DA Rule 6A-1.099811 that interventions and support strategies must be established for traditional public schools; therefore, prescribing, reporting, and setting requirements to review and monitor the progress of schools are essential to proper assessment. This analysis of progress monitoring assessments shall "help teachers understand how good tests can contribute to the effectiveness of teaching and how scores can aid in individualized instruction" (Hollingworth, 2007, p. 341). However, the DA Rule 6A-1.099811 does not indicate that non-tested areas should participate in progress monitoring. Therefore, schools put more emphasis on science in Grade 5 and not the other grade levels because they are not state tested in the area of science.

Students are mandated by the state to take the Grade 5 FCAT 2.0 science achievement test. Even though the FCAT 2.0 Science Assessment includes approximately 81% of the current year's content and 19% of previous years' content, no current guidelines exist in the DA Rule to ensure subjects not assessed by the state are monitored for progress. Furthermore, no state measures are in place to ensure science benchmarks are taught and assessed at the cognitive complexity of the 5th grade FCAT 2.0 Science Assessment.

Background and justification. In 2003, Kern, Andre, Schilke, Barton, and McGuire expressed that there was an educational change and teachers are held to higher standards in order for students to reach proficiency. They mentioned that high standards will not be possible if teachers continue to use rote learning and read and answer questions from the textbooks and worksheets (Dixon & Wilke, 2007; Blank 2013). Carnevale, Smith, and Stroll (2010) estimated that by 2018, there will be more than 2.8 million job openings for STEM workers; 92% of these jobs will require at least some postsecondary education. However, lacking science concepts, some students may not choose to continue their postsecondary education in science-related fields (Blank, 2013; Passmore, Stewart, & Cartier, 2010).

The International Association for the Evaluation of Educational Achievement (IEA) reported the science and mathematics international data from the Trends in International Mathematics and Science Study (TIMSS) every four years (Martin et al., 2011). The 2011 results of the TIMSS (see Table 2) showed that out of the 52 countries that participated, Korea and Singapore were the top-performing countries in science at the Grade 4 level, followed by Finland, Japan, the Russian Federation, the Republic of China, and the United States.

Table 2

TIMSS 2011 4th Grade Distribution of Science Achievement Countries

Country	Average scale score
Korea, Rep of	587
Singapore	583
Finland	570
Japan	559
Russian Federation	552
Republic of China	552
United States	544

The 2015 results of the study (see Table 3) showed that, out of the 57 countries that participated, Singapore and Korea were the top-performing countries in science at the Grade 4 level, followed by Japan, the Russian Federation, Hong Kong, Chinese Taipei, Kazakhstan, Poland, and the United States.

Table 3

TIMSS 2015 4th Grade Distribution of Science Achievement Countries

Country	Average scale score
Singapore	590
Korea	589
Japan	569
Russian Federation	567
Hong Kong	557
Chinese Taipei	554
Kazakhstan	550
Poland	547
United States	546

According to the National Center for Education Statistics (2015), U.S. students made slight improvement in 2015 from the previous years of 2003 and 2007. However, the report noted that there is no measurable difference between the average science score in 2015 and the average science scores in 1995 or 2011. It was also noted that even though there was a difference in the average score, it was not statistically significant.

A second component of the TIMSS results was the 14 benchmarking participants. The benchmarking participants were defined as states or cities from various entities around the world. In 2011, Florida ranked the highest among the benchmarking counties shown in (see Table 4).

Table 4

TIMSS 2011 4th Grade Distribution of Science Achievement Benchmark Participants in Various Locations Around the World

Benchmarking Participants	Average scale score
Florida, US	545
Alberta, Canada	541
North Carolina, US	538
Ontario, Canada	528
Quebec, Canada	516
Dubai, UAE	461
Abu Dhabi, UAE	411

Again, in 2015, Florida ranked the highest among the benchmarking locations within countries shown in (see Table 5).

Table 5

TIMSS 2015 4th Grade Distribution of Science Achievement Benchmark Participants in Various Locations Around the World

Benchmarking Participants	Average scale score
Florida, US	549
Ontario, Canada	530
Quebec, Canada	525
Dubai, UAE	518
Norway	493
Buenos Aires, Argentina	418
Abu Dhabi, UAE	415

In comparing the average scale score with like populations, Florida and Kazakhstan had the closest populations (see Table 6).

Table 6

TIMSS 2015 4th Grade Distribution of Science Achievement Comparison of Florida and Kazakhstan

Benchmarking Participants	Population	Average scale score
Kazakhstan	17.54 million	550
Florida, US	20.27 million	549

Achievement on the TIMSS assessment is based on four international benchmark achievement levels: advanced, high, intermediate, and low. According to the 2011 and 2015 TIMSS reports, Singapore and Korea scored in the top percentage among the other countries (see Tables 2 and 3). Also, those are the two countries with the largest percentage of students reaching the Advanced International Benchmark. Based on the TIMSS report, the percentage of U.S. Grade 4 students who reached the Advanced International Benchmark was 14% in 2011 and 16% in 2015; therefore, the United States is successful in educating over 80% of their Grade 4 students at the “a basic level of science achievement” (Martin et al., 2011, p. 85; Martin et al., 2016, p. 45). The students in the United States who are not achieving Advanced International Benchmark are not able “to interpret results in the context of a simple experiment, reason and draw conclusions from descriptions and diagrams, and evaluate and support an argument” (Martin et al., 2011, p. 85).

Even though the TIMSS report ranks Florida as the highest among the benchmarking participants at the 4th grade level, comparing the benchmarking participants to the countries in the TIMSS study, Florida ranks lower than the seven top countries in Table 3. According to the Florida Department of Education (2016a), low science achievement is a problem throughout the state among Grade 5 students. This assertion is supported by the TIMSS reporting that students in the United States learn science only at a basic level. In 2016 and 2017, 51% of Grade 5 students were considered proficient in science (see Table 1). Therefore, 49% of Florida's students demonstrated a below satisfactory or inadequate level of success with the challenging content of the Next Generation Sunshine State Standards (Florida Department of Education Office of Assessment, 2016, and the Florida Department of Education Office of Assessment, 2017). Because 49% of Florida's Grade 5 students lack an understanding of science concepts, instructional change is needed that will result in students being able to master high level science concepts to compete in today's globally innovative economy (Martin et al., 2011; Taylor, Roth, Wilson, Stuhlsatz, & Tipson, 2017).

The rationale for a mixed methods study was to obtain the perceptions of the Grade 5 teachers and observe their application of Tyler's four-step model while teaching science (qualitative phenomenological component). The researcher also investigated whether using Tyler's four-step model statistically affected students' understanding of science concepts. The students were administered a pre-post assessment (quantitative component).

Deficiencies in the evidence. A vast amount of evidence exists regarding increasing science achievement in schools and Tyler's principles of curriculum and instruction; however, the current researcher found no research linking the two concepts. The researcher believes that Tyler's four-step process of curriculum planning can guide instructors to reexamine teaching and learning. Therefore, the researcher hypothesizes that use of the instructional design model can lead to teachers producing objectives that reflect their classroom goals, thus impacting curriculum, increasing the understanding of science concepts, and improving of science achievement scores among Grade 5 students in the district being studied in Florida.

Audience. The audience includes K-12 teachers, professors, administrators, policy makers, college and career personnel, curriculum companies, and researchers. The teacher participants directly benefited from participating and learning about the Instructional Design Model to increase science achievement. All members of this audience may benefit directly or indirectly from the study outcomes as they relate to understanding ways to improve science curricula, instruction, assessments, and planning.

Purpose Statement

The purpose of this mixed methods study is to determine the degree to which the use of Tyler's instructional design model will affect Grade 5 student achievement in science. A convergent mixed methods design will be used; in order to collect data in this type of design, the qualitative and quantitative data are collected in a lateral fashion, analyzed separately, and then merged together. In this study, students' test scores will be used to test the instructional design model that predicts that teacher instruction will positively influence the test scores for students at Local School A. The researcher will explore the lived experiences about teaching new instructional strategies for teachers at Local School A. The reason for collecting both quantitative and qualitative data is to determine whether the use of the instructional design model by teachers improves students' science achievement scores.

Definitions of Terms

Achievement gap. When one subgroup of students outperforms another subgroup of students (Johnson, 2016).

Data chats. The process in which educators meet to discuss student assessment results in order to establish goals and instructional decisions (Florida Department of State, 2013).

Differentiated accountability (DA). The process in which the state and district incorporate accountability and align rigorous instruction to meet the needs of No Child Left Behind and implement school improvement strategies (Iatarola & Gao, 2015).

Florida Comprehensive Assessment Test (FCAT) 2.0. Assessments that measure student achievement according to the Next Generation Sunshine State Standards (Achievement Levels, 2014).

Inquiry. Learning through experiments and discovering conclusions through a variety of learning styles (Hardin, 2009).

Instructional design model. A cognitive learning theory with a learner-centered approach applied in the education profession (Denham, 2002).

Progress monitoring. The assessments that keep educators informed about students' progress in grade-level skills during the school year (Florida Department of State, 2013).

Scientific literacy. The understanding of the content of science and understanding of how that information was generated and justified (Passmore, Stewart, & Cartier, 2010).

Science Next Generation Sunshine State Standards. The Florida Department of Education statements that describe the knowledge or ability a student should be able to demonstrate in the science content area, adopted in 2008 (Florida Standards, 2009).

Subgroup. Students grouped by race, ethnicity, gender, or socioeconomic status (Johnson, 2016).

Trends in International Mathematics and Science Study (TIMSS). An extensive, cross-national comparative study of student performance administered every four years in mathematics and science (Martin et al., 2016).

Chapter 2: Literature Review

This chapter describes the historical overview of education from both national international perspectives. The researcher explored the historical overview to gain an understanding of the education and history of science education specifically. To comprehend the instructional design model, three aspects were reviewed: learning objectives, implementing and organizing learning experiences, and the evaluation of learning experiences. When implementing these components, there is evidence that supports the need for change in traditional science education.

Nature of the Problem

Elementary level science instruction has evolved throughout the years. Initially, scientists wrote the science curriculum with minimal laboratory experiments (Steiner & Fox, 1977). Today, the prevalent model of transmission includes lectures, presentations, and reading, versus the recent model of constructivism where students lead classroom science discussions and have multiple hands-on laboratory experiments (Worker & Smith, 2016). However, as science instruction has progressed, minimal improvements in science proficiency have occurred (Geier et al., 2008). In elementary schools, while students can do the experiments, they do not make the connections or articulate the science content connections because their teachers lack science understanding and are not able to plan efficiently for the lesson (Buaraphan, 2011; Herrenkohl & Tasker, 2011; Mangrubang, 2004). In an action research study involving kindergarten through Grade 6, it was found that when elementary teachers deconstructed the concepts and discussed possible misconceptions, the teachers were able to plan, teach, and facilitate science content and laboratory experiments effectively (Cullen, Akerson, & Hanson, 2010).

A design-based learning approach for science classes would assist in student achievement and the comprehension of science concepts (Mehalik, Doppelt, & Schuun, 2008). The system-design approach also aligns with the process of developing a curriculum. Herrick and Tyler (1950) defined school curriculum as “all of the learning which is planned and guided by the school” (p. 45). Therefore, the curriculum is the driving force behind planning and executing lessons. As science teachers become prepared to teach science through connecting science to the real world, managing lessons using inquiry and centers, implementing hands-on experiments, connecting science and literacy, and incorporating technology, they should be able to improve student achievement.

United States Historical Overview and Best Practices

Educational trailblazer. According to Gordon (2016), John Dewey was known as the revolutionizer in the field of education. In 1894, he started an experimental educational elementary school and was known as an academic philosopher and a proponent of educational reform. He transformed education through his innovative thinking and nontraditional approaches to teaching (Tarrant & Thiele, 2016). Gordon (2016) stated that Dewey “believed [that] there is a balance between teacher and student-directed learning and one in which teachers take an active role in the learning process, including formal teaching” (p. 1081). Dewey was disappointed in science education and thought it was fact based and not inquiry based (Na & Song, 2014). Rudolph (2014) suggested that “the blame for this, he insisted, could be pinned on a school science that was more concerned with the concepts and theories of the specialist than with the interests of the average person” (p. 1). Dewey believed that if science was revamped and the understanding of the method of science was present, then students would be able to better understand science (Anderhag, Hamza, & Wickman, 2015; Rudolph, 2014).

Pre-World War II era 1939. In the Pre-World War II era, high school science fairs were popular; science was presented as a body of facts, and science was magical entertainment to promote products. (Terzian, 2009) During this time, there was an influx of pressure to increase the number of high-achieving youth to defend the United States and strengthen the economy (Terzian, 2009). Therefore, in 1938, a general science course was added to the Grade 7 and Grade 8 curriculum to increase interest in science careers. (Terzian, 2009)

Post-World War II era 1945. After World War II, the United States started to rebuild the economy, the population increased, and people wanted more for their children. They wanted better lives, education, and jobs. This resulted in the reopening of many schools that were closed during the war and the building of additional schools. The educational system was being rebuilt, but science education remained an issue and teaching information was still the focus. The launch of the Russian satellite Sputnik led to Congressional hearings (Branscome, 2012). These hearings resulted in various educational findings such as: science courses were theory based, science was not connected with general education, the subject was too rigorous for the average student, and courses were difficult to teach. This led to the National Defense Education Act of 1958, designed to improve teaching in the sciences, foreign languages, and mathematics (Sanders, 2010).

Elementary and Secondary Education Act. Barely into the 1960s, the goal of the nation shifted from the concern of Russian technology to failing schools (Branscome, 2012). In 1965, under the Johnson administration, the Elementary and Secondary Education Act (ESEA) was passed (Bishop & Jackson, 2015; Sharp, 2016; Standerfer, 2006). This act primarily impacted schools with federal funding and its goal was to fill an achievement gap that existed among students from different backgrounds that could be decreased by improving the quality of education (Bishop & Jackson, 2015; Sanders, 2010; Standerfer, 2006). Sanders (2010) noted that Johnson believed that “education was a solution to the pernicious problem of poverty. Lack of jobs and money were a symptom of poverty; lack of education was the cause. Education aid, therefore, was the natural continuation of the already-passed poverty legislation” (p. 18). Sanders referred to Johnson’s beliefs that school districts should be responsible for four major tasks: (a) provide a better education to disadvantaged youth, (b) provide students with the best technology, equipment, and innovations, (c) provide teachers and students with the best technology and training, and (d) provide student and teacher incentives.

In 1983, the National Commission on Excellence in Education released *A Nation at Risk.* This was a report designed to open the eyes of Americans regarding the basic purpose of schooling, high expectations, and discipline in the schools (Park, 2013). The Commission identified five areas of concern which generated the following recommendations: “curriculum content, standards, and expectations of students, time devoted to education, teacher quality, and educational leadership, and the financial support of education” (United States Department of Education, 2008, p. 8). The science standards were not clear, specific, or academically rigorous, which resulted in "a steady decline in science achievement scores of U.S. 17-year-olds as measured by national assessments of science in 1969, 1973, and 1977” (Garner, 1983, p. 9). *A Nation at Risk* “fueled a standards-based movement” (Bishop & Jackson, 2015, p. 3). However, this act resulted in lowered standards and expectations for public institutions (Branscome, 2012; Park, 2013).

No Child Left Behind Act of 2001. In 1989, discussions for significant reforms in the educational system at the federal level began, which led to the enactment of the No Child Left Behind Act (NCLB) of 2001. The NCLB Act was an attempt to increase and improve educational opportunities for all students and to ensure that all schools would be held accountable (Johnson, 2016; Park, 2016). The act required every state to set specific goals for adequate yearly progress and attach a set of prescriptive escalating sanctions for schools that failed to meet the expected standards (Johnson, 2016). This prescriptive act ensured that states that received federal educational funding measured and reported state test scores with a special emphasis on math and reading. Also, by the 2007-2008 school year, science tests were administered at least once during grades 3-5, grades 6-9, and grades 10-12 (United States Department of Education, 2008).

Every Student Succeeds Act. In 2015, President Barack Obama signed the Every Student Succeeds Act (ESSA). This law reinstated the Elementary and Secondary Education Act, a civil rights law that seeks to ensure that every child has “the opportunity to obtain a high-quality education and to give more flexibility to the states” (Elementary and Secondary Education Act of 1965). According to Johnson (2016), the ESSA “was expanding access to a high-quality education [that] can play a significant role in reducing disparities in educational, social, and economic outcomes for children” (p. 2). The ESSA is less rigid than the NCLB and requires states to adhere to federal law regarding federal funding; however, the act gave states more autonomy in determining student assessments, accountability, school improvements, and teacher and school leader effectiveness (Johnson, 2016; Sharp, 2016). The ESSA specifically emphasizes the continued need to support struggling schools and that assessments are the central focus in determining student achievement. This support included summative data collection for targeted schools in which the schools must show improvement at least once every three years in closing the achievement gap in statewide proficiency (U.S. Department of Education, 2016). The ESSA also maintained the science assessment schedule that mandates that state science assessments must be administered at least once during grades 3-5, grades 6-9, and grades 10-12 (Johnson, 2016; Sharp 2016).

National educational best practices. American educational best practices are widely spread throughout the nation. Education age groupings in America consist of pre-school ages three to six, elementary school ages six to 11, middle school ages 11 to 13, and high school ages 14 to 18. Schools balance multiple layers of governing bodies that include federal, state, and local entities and stakeholders that include parents, the community, and students (Park, 2013). School districts increased opportunities for cooperative learning, project based-learning, the use of technology, and academic ability grouping to increase the atmosphere of achievement (Wilde, 2015). Districts also focused on teacher retention through the New Teacher Center, a support system for beginning teachers. This program provided new teachers with a mentor and professional development. After-school activities were offered to students to assist with remediation or enrichment (Park, 2013). Therefore, students were given an opportunity to receive additional instruction designed to increase their academic achievement before and/or after school.

International Historical Overview and Best Practices

The following section will take a brief look at education in the top seven countries that outscored the United States in science as reported by the TIMSS science international assessment. The researcher will attempt to compare the relationships among time spent in school, educational philosophies, and science exposure in these counties as they relate to the TIMSS assessment international rankings.

Singapore. Singapore is one of the most advanced countries in Southeast Asia; it has built and sustained a high-quality education system (Deng & Gopinathan, 2016). Education in Singapore consists of pre-school ages three to six, primary school ages seven to 11, and secondary school ages 12 to 17. The school term for students in Singapore starts in January and ends in November and is divided into two semesters with four terms. The academic year has 180 days of school over a total of 36 weeks. There are four vacation periods, one at the end of each term for ten days, then a two-month vacation at the end of each year (Ministry of Education Singapore, 2018).

In Singapore, students are taught in English for their core subjects; therefore, the students are bilingual. Since the students are bilingual, the country is further developing in science and technology and increasing its industrialization (Istiningsih, 2016). There is an expectation of high teacher quality, school leadership, system characteristics, and education reform. According to Deng & Gopinathan, (2016) in 1997, Prime Minister Goh’s speech, entitled Thinking Schools and Learning Nation, “addressed the conditions of nationhood and globalization and laid out a more student-centric, active learning paradigm, with the aim of producing autonomous and independent learners with the capacity to think, innovate, and learn continuously” (p. 457).

The educational system in Singapore is based on the belief that all schools should provide students with skills, character, and values that will enhance the future of Singapore. The Ministry of Education’s goal is “to help our students to discover their own talents, to make the best of these talents and realize their full potential, and to develop a passion for learning that lasts through life” (p. 1). In recent years, Singapore has developed a broad educational system to provide students with choices in academics, sports, and the arts.

Singapore’s education model is grounded on character education and the identified pillars that help to build character. The most powerful basis of building character is motivation; according to Istiningsih, (2016) “education actually builds the motivation. Motivation is such like spirit that can be manifested into characters” (p. 35). The move to use less traditional modes and the government’s unrelenting push for pedagogical change have assisted in Singapore’s educational success. In the past, the three distinctive features of the pedagogical structures included preparing students for examinations by focusing on the national curriculum; using textbooks, worksheets, and homework; and checking for content mastery (Deng & Gopinathan, 2016). However, in 2003, the government launched the Teach Less, Learn More (TLLM) initiative to improve the quality of interactions between the teacher and the student. According to Kaur (2014), “the TLLM initiative emphasizes ‘more quality’ in terms of classroom interaction, opportunities for expression, the learning of life-long skills and the building of character through innovative and effective teaching approaches and strategies” (p. 5).

Republic of Korea. The Korean educational system is comprised of three stages: primary school, middle school, and high school. The academic year in Korean schools is split into two semesters with four terms. The students are given two-week vacations within these semesters. The vacation days are determined by each school site. The school year is comprised of 220 days over a total of 44 weeks. Korean public authorities currently have total control of the nation's education process (Krechetnikov & Pestereva, 2017). The educational system in Korea is highly standardized and regulated by the central government (Park, 2013). Korea's Ministry of Education, Science, and Technology has created educational policies to increase diversity in education (Krechetnikov & Pestereva, 2017; Park & Sung, 2013) and promote educational excellence, "excellent schools and diverse curricula, creativity and character education, teacher expertise, and reduction of private education expenditure" (Park, 2013, p. 26). They use departmentalized classrooms, where students have different teachers for their core concepts (Park & Sung, 2013).

In recent years, Korea has moved from a teacher-centered to a student-centered format. Also, students participate in after school activities to help build character and responsibility (Park, 2013). Technology literacy is a high priority and the government provides free 24-hour Internet access, creating a cyber home and cyber school atmosphere (Krechetnikov & Pestereva, 2017). The Ministry of Education, Science, and Technology implemented SMART education:

> SMART learning is an intelligent, tailored instruction-learning supporting system, in which the demands of the 21st century information technology society are met with changes in the overall education system such as pedagogy, curricula, assessments, and teachers. It is a combination of human centered social learning

> and adaptive learning, based on the best network communication environment. (Park, Choi, & Lee, 2013, p. 323)

This approach is designed to increase their student achievement and develop future global leaders. Additionally, Korean teachers are some of the highest paid when compared to other countries and teaching is one of the most popular career choices (Im, Yoon, & Cha, 2016). Therefore, their teacher quality is higher, they are highly respected, and they are competitively compensated (Im et al., 2016; Park, 2013).

Japan. Japan's educational system consists of primary school, secondary school, and high school. The school year is comprised of 240 days over a total of 48 weeks. The Japanese school year follows a three-semester system, separated by vacations (Ministry of Education, Science and Culture, and the Science and Technology Agency, 2018). Japan is known for a history of "superior performances in the sciences" and aims to have a "national power in education" (Sumida, 2018, p. 280). According to Nakayasu (2016), Japan "aims to have students acquire 'Zest for Life', which is considered as a basic goal of current school education in Japan" (p. 137). The students in Japan are encouraged to think critically and use creative writing, problem solving, and the scientific process throughout the curriculum (Krechetnikov & Pestereva, 2017; Nakayasu, 2016). Japan is also known for its implementation of internationalized higher education and student exchange programs (Krechetnikov & Pestereva, 2017). In the recent years, Japan has increased the programs for gifted students including providing after-school enrichment programs and clubs (Sumida, 2013). "Japanese students have consistently been among the top performers in the world in mathematics, science, and reading on the PISA and TIMSS exams" (Ahn, Asanuma, & Mori, 2016, p. 28).

Finland. According to Tirri (2014), “Finland has created an educational system with the following characteristics: uniformity, free education, free school meals and special needs education” (p. 602). Education in Finland consists of pre-school ages three to six, primary school ages seven to 11, and secondary school ages 12 to 17. Finnish students enjoy free education from pre-school to high school. The school year is comprised of 190 days over a total of 48 weeks. School takes place between August and June, with the vacation time occurring from mid-June to early August (Ministry of Education and Culture, 2017). Finland has revised its education evaluation policy to increase its focus on national curriculum, teachers’ professional development, and digital schools (Niemi, Toom, & Kallioniemi, 2016). Since the 1970s, Finland has restructured its teacher preparedness programs to include teachers in all grade levels via the Teacher Education Act (Jenset, Klette, & Hammerness, 2018; Sahlberg, 2011; Tirri, 2014). The Finnish educational system increased the hands-on experiences for students in mathematics and science over the years. This increased their international ranking in mathematics and science from the 1990s to 2017 (Ministry of Education and Culture, 2017).

Since the 1960s, Finland has focused on the needs of individual students and the prime objective of educational equality (Niemi, Toom, & Kallioniemi, 2016). In Finland, the goal of the Ministry of Education is to guide schools on a positive path by not invading schools with policies but allowing teachers to have autonomy (Tirri, 2014). In the early 1990s, Finland stopped school inspections and moved toward trusting the teachers to be proficient and self-reflective (Ministry of Education and Culture, 2017). Tirri (2014) expressed that “teachers are trusted and respected, and the profession attracts good students year after year. This is a unique advantage to teacher education in Finland by comparison with other countries" (p. 607).

Russia. Russia's educational system consists of pre-school ages one to six, primary school ages seven to 11, and secondary school ages 12 to 17. The school year is comprised of 170 days over a total of 34 weeks. The Russian school year is comprised of four terms with two-week vacations in November, January, and March, and nearly three months in summer. The school year is held from September 1st until the final week of May (Cheidvasser & Benítez-Silva, 2007).

In 1917, Russia was turned into a communist republic as a result of the Bolshevik Revolution. At that time, the country was 66% illiterate because children started working at a very young age. In 1919, free education was accessible to all, and by the early 1930s, the illiteracy rate had dropped to 38%. In 1956, the Twentieth Communist Party Congress determined that the curriculum was not rigorous enough; therefore, they decided to restructure the educational system. (Cheidvasser & Benítez-Silva Russians, 2007). In the mid-20th century, educational policy was dictated by the Communist Party. "The Party serves as the seedbed of power not only in economics and politics but also in the realms of ideology and education" (Chabe, 1971, p. 525). The educational ministries led to the administration of public education; however, all changes to any education policy had to be approved by the party (Chabe, 1971). According to Cheidvasser and Benítez-Silva (2007), "Russians have seen their economy shrink and are still suffering a mounting erosion of their purchasing power as well as a rocketing of corruption and organized crime in all levels of society" (p. 1). Russia struggles with the inequality of resources to poor areas, which results to a large gap in educational services between poor-performing and well-performing schools. (Nikolaev & Chugunov, 2012). Russia is also struggling in comparison with other central and eastern European countries undergoing the transition from a socialist to a market economy (Totten, 2013).

The population of schools in Russia were large because they were primary through secondary. Therefore, to increase student performance in 2000, the Russian Federation decided to decrease the number of large schools and to increase the number of primary and secondary schools in separate locations, "providing better conditions for provision of high-quality educational services" (Nikolaev & Chugunov, 2012, p. 22). "Primary and secondary education lays the foundation for the development of a broad range of skills and prepares young people to become lifelong learners and productive members of society" (Nikolaev & Chugunov, 2012, p. 19). In comparison to other countries, Russia's dropout rate is among the lowest in the world (Nikolaev & Chugunov, 2012).

Republic of China. According to OECD (2016), "China has the largest education system in the world" (p. 7). Education in China consists of pre-school ages two to six, primary school ages seven to 11, and secondary school ages 12 to 17. In China, the school year consists of 180 days spread over 36 weeks. School is conducted five days a week with an optional day on Saturdays (Hill, 2011). The summer vacation starts in mid-July or mid-August and usually lasts about a month (China's education, 2016; OECD, 2016). For centuries, China's educational system was perceived as authoritative. This was due to rote memorization and hard work being a contributing factor to the countries excellent test scores (Zhao, 2014). In 1966, Chairman Mao Zedong initiated the Cultural Revolution, which resulted in a disruption of many children's education in China. This lasted from 1966 to 1976. According to Giles, Park, and Wang, (2015) “the extent of the disruptions differed across cohorts, across time, and across cities, depending on how zealously new policies were interpreted and implemented locally. As a result … the schooling of many Chinese citizens was delayed or cut short” (p. 4). According to OECD (2016), “the government regularly adjusts and advances education policy to make the system compatible with the country’s social and economic development, as well as new education needs and trends” (p. 13). The Ministry of Education of the People’s Republic of China develops policy and the states carry out the policy (Giles, Park, & Wang, 2015; OECD, 2016). In 1978, China implemented economic reform and became one of the fastest growing global economies (OECD, 2016). In 2014, China’s enrollment in vocational schools increased due to the large economic demand for skilled workers (KPMG, 2010; Schleicher & Stewart, 2008). Currently, OECD (2016) expressed, “the Ministry of Education has set four areas of priority: 1) rural, remote, poor and minority areas; 2) primary education in rural areas, vocational education and preschool education; 3) subsidies for students from poor families; and 4) building a high-quality team of teachers” (p. 16).

The TIMSS results in chapter one discussed the international science data. The data showed that Singapore, China, Korea, Finland, Japan, Russia, and the United States have varied scores. These countries also had different educational systems. The days in school were wide-ranging, from 170 to 240 days. In some cases, the days of school and the performance did not align (i.e., the longer the school year the higher the science achievement). This was disproven because Singapore has the highest science achievement and has one of the lowest numbers of days in school. However, it is likely that there is a relationship between more time on task and high achievement scores. Furthermore, the value placed on education in each country has an intangible impact.

Theoretical Framework

Instructional design model. Ralph W. Tyler (1902-1994) developed an instructional design model that is used in education (Denham, 2002) “to make learning more efficient, effective, and less difficult” (Morrison et al., 2011, p. 2). In the education field, professionals can use the basic principles of instructional design process to ensure that the purpose of the course is being fulfilled. This process can also help educators to ensure that the students are learning through appropriate delivery and engaging activities that are being continually evaluated and improved (Morrison et al., 2011). According to Martin et al. (2011), “science has direct application to nearly all aspects of life and society, from maintaining and improving human health to understanding and solving local, regional, and global environmental issues” (p. 23). Therefore, science instruction and the application of science concepts to real-world experiences must be meaningful and organized.

During Tyler’s tenure as a professor at the Ohio State University, he assisted the university in improving teaching skills and student retention. At that time, in 1942, he developed the instructional design model. Tyler referenced this design model in his work, *The Basic Principles of Curriculum and Instruction* (1949). He developed the instructional design model based on the results of a study that involved 30 high schools and 300 colleges and universities. The instructional design model introduced educational ideas by addressing four questions:

1. What educational purposes should the school seek to attain?

2. How can learning experiences be selected which are likely to be useful in attaining these objectives?

3. How can learning experiences be organized for effective instruction?

4. How can the effectiveness of learning experiences be evaluated?

The instructional design model is based upon the learning objectives, implementing and organizing learning experiences through content and teaching methods, and evaluating the learning experiences. Within the framework of the instructional design model, teachers understand the rationale in planning instruction that includes engaging differentiated lessons, real-world application models, and preparing meaningful standards-based assessments. The instructional design model process may alleviate the pressures of assessments for teachers and students. Thus, both will improve on a continuous basis, make connections from the learning experiences, and improve the overall temperament of the classroom.

Learning objectives. The concept or idea of having objectives was introduced by Pavlov in the 1800s, resulting from his study regarding the conditioning of dogs. His work was followed up by two American psychologists: Watson and Skinner. These two psychologists also explored the impact of external stimuli on learning. Their research greatly influenced teaching in the United States and eventually led to the idea of measuring learning outcomes, a process in which learning objectives became an integral component. Learning outcomes have implications for curriculum and the assessment of curriculum and learning outcomes are important in measuring learning objectives. Learning objectives are specific instructional goals that students will master by the end of the lesson. The connection between the goals and student experiences in the classroom will allow the teacher and student to have the same end in mind. Tyler noted in his work that students who are taught useless information will not retain the knowledge long term. It is important for teachers to consider the students’ prior and current knowledge, and then determine how to decrease the gap between what they know and what they need to know (Herrick & Tyler, 1950; Nowakowski, 1983; Wilson, 2014). Using this information will assist the teacher in creating learning objectives that are rigorous and relevant.

Implementing and organizing learning experiences. When there is an effort to organize learning, there is evidence of collaboration and organized intentional learning experiences (Herrick & Tyler, 1950). Therefore, classroom learning will be seamless if classroom activity management is organized and planned. Students will retain information and increase learning when learning experiences are organized, high-quality, and rigorous (Geier, Blumenfeld, Marx, Krajcik, Fishman, Soloway, & Clay-Chambers, 2008). It is important for teachers to plan the implementation of the lesson to provide an order of experiences based on what the student knows and needs to know, not solely teaching benchmarks in isolation or teaching page by page from a textbook (Herrick & Tyler, 1950; Wilson, 2014).

Evaluation of learning experiences. Evaluating learning experiences is determining the effectiveness of learning experiences. This is a process of aligning the learning objectives and assessments to determine whether teachers have effectively taught the science concepts. During an interview with Tyler, Nowakowski (1983) asked about evaluating objectives. Tyler responded that “you can’t use just objectives as the basis for comprehensive evaluations, but it is very important to find out whether teachers are accomplishing their purposes” (p. 26). Hamilton (2003) reported that teachers’ morale and stress levels affect their ability to determine what is needed in the classroom and that teachers feel more pressure because of assessments. Currently, one of the causes of low assessment scores is pay; therefore, “when test scores are associated with consequences that are important or meaningful to teachers, it is likely that instruction will be affected” (Hamilton, 2003, p. 33). Consequently, if teachers review the science content, create learning objectives, and then develop learning experiences, alignment of the assessment will be an easier process (Webb, 2007), and they most likely will feel less pressure.

Summary of instructional design model. The instructional design model’s components of purposeful lessons include learning goals, organization of the lesson, and assessments of learning. Effective learning decreases stress and the anxiety of planning and assessing student outcomes. This process may be used to build consensus and communication among teachers to align resources with the goal of student achievement to improve school and classroom science engagement.

Additional Best Practices

Science connections and management. Poor science achievement is occurring because of teachers’ inability to make science connections, relying only on reading strategies, and failure to implement hands-on activities (Buaraphan, 2011; Fischer et al., 2009; Herrenkohl & Tasker, 2011; Mangrubang, 2004; Passmore, Stewart, & Cartier, 2010). Science connections refers to identifying science concepts, using models, applying knowledge, making connections to the real world, analyzing data, and interpreting data, all of which contribute to students being able to reason abstractly and quantitatively (Making connections in math and science, 1994; Metz, 2014). In elementary school science classes, teachers and students do not make the aforementioned connections

(Herrenkohl & Tasker, 2011) because there is a disconnect between the science content and science lesson plans. In a 4-year evaluation, Banilower, Fulp, and Warren (2010) noted a principal's description of science prior to the implementation of the elementary science hands-on program: "They were doing things out of a textbook, but not a lot of hands-on things. The teachers were not as comfortable with the material, so they may have not gone into as much detail as they do about different topics" (p. 8). In an action research project involving K-Grade 6 science teachers, Cullen (2010) reported that elementary teachers were having trouble identifying students' prior knowledge of science concepts. Therefore, a teacher who does not understand scientific processes and has difficulty relating science to the real world cannot plan and facilitate laboratory experiments effectively (Buaraphan et al., 2011; Mangrubang, 2004). This inability to make science connections may lead to the teacher feeling frustrated, having increased anxiety, and displaying poor teacher authority and control (Buaraphan et al., 2011; Oliveira, 2009).

Science reading. One cause of poor science achievement is the "mismatch between the current focus on reading-strategy instruction and the actual requirements for understanding science reading" (Fischer et al., 2009, p. 183). In some classrooms, teachers are emphasizing reading strategies such as predicting, inferring, connecting, summarizing, visualizing, and questioning during science instruction. For example, within a lesson, students may read a science text and complete a worksheet; this type of activity would not result in a greater understanding of a complex science topic (Fischer et al., 2009). This traditional approach fails to ensure that all students are understanding and applying the concepts; even high-achieving students struggle with mastering concepts with this approach (Mangrubang, 2004). Banilower et al. (2010) expressed a concern for reading and hands-on connections in science class, explaining that teachers would have students read text and answer questions without connecting the reading to an activity or experiment. In this way, they missed opportunities to connect the reading to a practical experience. In science, students investigate a problem and collect data; in reading, "students ask questions and take notes" (Belk, Seed, & Abdi, 2005, p. 44).

Science understanding is better accomplished through providing students with textual materials and connecting experiences with the science investigations (Cervetti & Barber, 2009). For example, if students were investigating various soda recipes, they could use various textual materials to obtain information about how food scientists created various flavors of jelly beans. Then, the students could organize their findings from the reading and design and create a new flavor of soda using the scientists' jellybean investigation (Cervetti & Barber, 2009). If this took place, students would then be able to use reading strategies to clarify and gain an understanding of the science text (Fischer et al., 2009) and make connections to the activity (Dalton & Proctor, 2007). There is evidence that when science activities and literacy increase, student achievement increases (Lundstrom, 2005). A combination of science literacy, activities, and experiments "builds a richer collection of evidence" (Cervetti & Barber, 2009, p. 21), ensuring that students understand and retain science concepts.

Lack of hands-on activities. Another cause of poor science achievement is the lack of hands-on activities in the science classroom because teachers lack an overall understanding of science and how areas of science connect (Buaraphan et al., 2001; Passmore et al., 2009; Stewart & Cartier, 2010). The majority of elementary school teachers prefer direct instruction, have limited knowledge of science concepts, and are unable to plan hands-on science activities effectively (Jantarakantee, Roadrangka, & Clarke, 2012; Leonard, Boakes, & Moore, 2009). This situation exists because teachers who are certified in elementary education are generally only exposed to one to two science education methods courses in elementary education degree programs (Leonard et al., 2009; Mangrubang, 2004; Velthuis, Fisser, & Pieters, 2014). Their lack of science education and understanding is often coupled with misconceptions of science concepts and negative attitudes toward science (Buaraphan et al., 2001; Bulunuz & Jarrett, 2010; Choi & Ramsey, 2008; Subramaniam, 2013; Velthuis et al., 2014); consequently, inadequate preparation for hands-on science activities results in low achievement levels (Aslan, Tas, & Ogul, 2016; Kang, Bianchini, & Kelly, 2013; Mangrubang, 2004).

Science classroom environment. Creating an environment of science-rich discussions and hands-on activities in the classroom will improve students' academic performance (Best Practice Briefs, 2004). The way in which the science classroom is structured affects student learning as well as their interdependence. Students' interdependence plays an intricate part in the classroom environment because students learn from each other. For example, studies have shown that students working in cooperative learning groups score significantly higher on assessments than students with direct instruction (Campbell, 2013). Also, classrooms with collaborative structures are more likely to have students on task, creating a positive structure in the classroom (Bonus & Riordan, 1998; Campbell, 2013; Patton et al., 2001; Wannarka & Ruhl, 2008). The science classroom environment should be a framework that includes collaborative activities, independent activities, and the articulation of science connections (Herrenkohl

& Tasker, 2011). Interdependence and collaboration are so important in learning science because the students will develop collaboration skills, social skills, critical thinking skills, and problem-solving skills that will increase student achievement and provide vital benefits in their future (Lee, Huh, & Reigeluth, 2015).

Professional development. Professional development provides teachers with the skills to become better teachers (Baker et al., 2009). The NCLB Act of 2001 (NCLB; Public Law 107-110), Section 1116, which addresses academic assessment, local educational agency, and school improvement, stated that leaders must “review the effectiveness of the actions and activities the schools are carrying out under this part with respect to parental involvement, professional development, and other activities assisted under this part” (p. 54). Therefore, professional development is encouraged, if not mandated, to improve teachers’ skills in needed areas. During professional development, teachers can increase their understanding of science concepts through hands-on inquiry methods, cooperative learning, manipulatives, technology, and real-life applications to increase their teaching effectiveness (Bulunuz & Jarrett, 2010). Professional development is important for teachers because it provides them with scientific literacy and classroom discourse (Baker et al., 2009), an understanding of the process of inquiry (Steele, Brew, Rees, & Ibrahim-khan, 2013) and an improvement of their self-efficacy (Velthuis, Fisser, & Pieters, 2013). Professional development will assist with teachers’ development in science content and instruction as educators (Baker et al., 2009; Cullen et al., 2010; Velthuis et al., 2013); therefore, effective professional development helps teachers become facilitators of learning in the classroom.

Role as facilitators. When the teacher becomes the facilitator in the science classroom, students will be equipped with the "skills to engage in scientific discussions, understand scientific arguments, and understand the role of discourse in the creation of scientific knowledge" (Baker et al., 2009, p. 261). There will be more evidence of students discussing and defending their answers in small groups. The teacher will be able to determine which students understand the concepts and which students need remediation on the skills. The teacher will introduce the concept at the beginning of the class and then gradually release the activity to the students. Consequently, the students will take ownership of their learning in the science class (Barney & Maughan, 2015).

Organizing and Implementing Learning Experiences

According to Panasan and Nuangchalern (2010), school personnel need to develop students in terms of scientific knowledge and critical thinking skills, do empirical activities based on the nature of science, and foster scientific literacy. When organizing learning experiences, it is important to understand the learning outcomes for the assignment. The teacher must, in planning the lesson, determine when students should be in cooperative learning groups, choose the appropriate collaborative structures, and differentiate between teaching science concepts in conjunction with reading strategies and using hands-on activities to reinforce those ideas (Herrenkohl & Tasker, 2011; Kose, Sahin, Ergun, & Gezer, 2010). The teacher should be able to determine during the lesson when it is appropriate to stop and ask questions (Lotter, Harwood, & Bonner, 2007) to ensure that student learning is taking place.

Inquiry learning. Geier et al. (2008) explained that "the more science instruction we are able to provide to students during their schooling, the larger the learning growth we will expect to see in the achievement" (p. 934). According to Oliverira (2009), "inquiry-based teaching is commonly defined as an instructional mode wherein the teacher relinquishes, at least partially, his/her science expert role by forfeiting interactional rights such as providing the right answers, telling students what to do, and evaluating student's ideas" (p. 804). Inquiry-based teaching involves the students' active participation and growth, helping students understand concepts in science, and doing so within an environment of learning. Inquiry-based learning focuses more on activities that incorporate learning based on natural-world experiments and conclusions from the evidence students collect. Inquiry-based teaching involves the students' and teachers' participation and growth for all to benefit (Choi & Ramsey, 2009; Panasan & Nuangchalern, 2010).

An inquiry learning approach is beneficial to teachers because students are more encouraged to learn and less encouraged to be distracted in the classroom. In a study on inquiry learning, Nuangchalerm (2014) found that "teachers can stimulate students' learning based on understanding the nature of science and practical science…[the] inquiry-based classroom can help students meet the goal of science education" (p. 69).

Inquiry learning is a key to cooperative learning and challenges students (Geier et al., 2008) as it opens communication among students, encourages scientific dialogue in the classroom, and increases student achievement and attitude towards science (Kose et al., 2010; Windschitl, Thompson, & Braaten, 2008). When teachers change the learning experience from whole-group activities to collaborative learning centers, students become accountable for their outcomes in the classroom, thereby increasing student achievement and social skills (Lee & Houseal, 2003; Smolleck, Yoder, & Zembal-Saul, 2006).

Evaluating the Effectiveness of the Learning Experience

In determining the effectiveness of the learning experience, the teacher must be able to analyze data and review to what extent the students mastered taught concepts (Webb, 2007). If the students were unsuccessful at mastering the concepts, then the teacher must review and modify the lesson plan to determine what worked and what improvements are necessary for student achievement (Contino, 2013). The teacher can also ensure that the science content, instruction, and assessments are all aligned (Fulmer, 2011; Webb, 2007).

Progress monitoring. According to Vannest, Soares, Smith, and Williams (2012), “progress monitoring is a formative process to assess students’ academic performance and evaluate the effectiveness of instruction” (p. 67). Progress monitoring tools are used to determine students’ growth in subject-area content based on the federal mandates of NCLB (Contino, 2013; Kane & Staiger, 2002; Newton & Kasten, 2013). The monitoring of students assists in determining instructional decisions and provides feedback to students and teachers (Newton & Kasten, 2013). Then, the teachers should use that data to determine what areas within the content they should spend more or less time teaching (Moher, Wiley, Jaeger, Silva, & Novellis, 2010).

The collection of data to drive instructional decisions does not always have to be a test or an assessment. The teacher can also collect data through observations, classroom notes, and student work (Cullen et al., 2010), referred to as formative assessments. These checks for understanding will also provide the teacher opportunities throughout the lessons to determine whether the students understand the concepts. The teacher will then be able to explore effective teaching and learning strategies.

Summative data collection. In the current and previous years of ESEA, NCLB Act of 2001, and the ESSA, it is mandated that states revise, develop, or adopt challenging academic content and achievement standards that will apply to all children in the state (Bishop & Jackson, 2015; Johnson, 2016; U.S. Department of Education, 2005; U.S. Department of Education, 2016). The content subjects included but were not limited to mathematics, reading or language arts, and science. These standards are required to be assessed yearly to determine whether students meet the state's academic achievement standards (Bishop & Jackson, 2015; Johnson, 2016; U.S. Department of Education, 2005; U.S. Department of Education, 2016). Therefore, an alignment of content standards, standardized tests, and instruction is vital (Contino, 2013; Fulmer, 2011; Timofte, 2015; Webb, 2007). However, Contino (2013) stated, "often times, standards are too general and can lead to the individual assessment items aligning but as a whole, the assessment not fully aligning with all of the content and skill requirements" (p. 72).

Research Questions

Three research questions will guide this study:

Quantitative. R1: What impact will the use of the instructional design model have on Grade 5 students' science post-test results?

H_{01}: The instructional design model will have no significant difference on the Grade 5 science post-test results.

H_1: The instructional design model will have a significant difference on the Grade 5 science post-test results.

Qualitative. R2: How has the instructional design model influenced a student's ability to understand and learn the science concepts being taught as observed and measured using a validated structured classroom observation form?

R3: How has the instructional design model influence a teacher's perceptions of student learning when reflecting on their previous teaching approach?

Subquestion 1: Did the teacher's perceptions translate into improved post-test results?

Chapter 3: Methodology

The purpose of this mixed methods study was to determine the degree to which the use of Tyler's instructional design model affected Grade 5 student achievement in science. Science assessment scores are very low for the high-risk student population identified in this study. The literature clearly supports that science teachers in elementary schools suffer from a lack of professional preparation within the discipline (Bulunuz & Jarrett, 2010; Gamoran & Borman, 2013; Steele et al., 2013; Trimmell, 2015; Velthuis et al., 2013). To address this situation, the researcher used a convergent mixed methods design in which the researcher collected and analyzed quantitative and qualitative data from two separate databases (Creswell & Clark, 2018). The science teachers involved in this study received professional development training using the instructional design model, a model that promotes multiple teaching strategies as noted in the literature review. In a structured interview, teachers were asked to share their experiences using the different strategies in teaching an eight-week science unit. The structured interviews occurred at the beginning and end of the eight weeks. The teachers were asked about their teaching experience using the instructional design model. Additionally, during the eight weeks, each teacher was observed teaching their science unit once every other week. The researcher also compared the Grade 5 students' pre and post test scores from the previous and present years. It was expected that students' academic achievements would improve in between the pre-assessment and the post-assessment.

Participants

Quantitative. The study was conducted in an inner-city elementary school in Florida, with a student population of 601 in grades K-5. The National Center for

Education Statistics (2018) reported that the school has an enrollment of 88 kindergarteners, 107 Grade 1 students, 106 Grade 2 students, 125 Grade 3 students, 104 Grade 4 students, and 93 Grade 5 students. Among them are 3% Caucasian students, 80.8% African American, 14% Hispanic students, 0.7% multiracial, and 0.2% Asian. The National Center for Education Statistics also reported that 100% of the students are on a free and/or reduced lunch; 8.3% students are classified as exceptional students and receive special education services. Of the school population of 601 students, the 93 Grade 5 students at the target school received science instruction and school wide data were used in this study. The students took a pre- and post-test for the current year. The current year post scores were compared to the post scores from the previous year. Once the ex-post facto data were collected, a t-test was performed to determine whether a statistical difference between the mean scores (*M*) of two groups existed. A t-test can be performed utilizing two methods. The first is a one sample t-test where different participants are in each group, while the second is the dependent (also referred to as matched or correlated) samples where the same participants are in each group (Gay, Mills, & Airasian, 2012). For purposes of this study, the one sample t-test was performed to compare the students' means scores for the post-test.

Qualitative. There are 25 teachers in the target school. Each teacher is responsible for teaching all core academic subjects (reading, language arts, math, science, and social studies). There are five Grade 5 teachers at the target school that were invited to participate in this study. Science in Grade 5 is taught four days a week for 45 minutes per day; a total of 180 minutes per week per the local district's school schedule. The ethnic make-up of the teachers is two Black females, one Hispanic female, one Black male, and one White male. The teachers have a variety of teaching experiences; four taught less than five years, one taught less than 10 years, and one taught more than 12 years. The researcher recruited and observed the teachers within the seven focused areas of instruction. The sampling procedure for collecting qualitative data involved conducting interviews and observations with the five Grade 5 teachers. The teachers received professional development (Appendix D) on the instructional design method as it applies to the teaching of science. Each teacher was observed every other week over an eight-week science unit (Appendix B). Additionally, the science teachers were interviewed individually and asked several questions (Appendix A) that focused on their perceptions of what transpired using the instructional design model while teaching the eight-week science unit.

Instruments

Three instruments were used by the researcher to obtain qualitative and quantitative data. The quantitative data collection instrument was a district Common Assessment (CA) for a particular unit and the qualitative data collection instruments were the structured interviews (Appendix A) and the teacher observation tool (Appendix B).

In this study, a multiple-choice assessment (the validated district-wide science assessment instrument) was used as the instrument to collect science achievement data to answer Research Question 1, which focused on the impact of the instructional design model on science achievement post-test results. The district provides various assessments for schools to use throughout the year that are created by teachers, school-based science coaches, and district science coaches. The assessments, referred to as CAs, are created by the district Curriculum and Instruction Department and designed to measure students' science achievement. To establish the validity and reliability of the post-test assessment, officials from the school district Curriculum and Instruction Department selected a team of science content development specialists to review all the questions. The items are high quality, test developed, aligned to state standards, and designed to follow the Florida Department of Education Grade 5 Science Item Specifications regarding item contexts, item difficulty, and multiple-choice items (Florida Department of Education, 2014). Kimberlin and Winterstein (2008) discussed the importance of reliability, defining it as when a survey instrument yields a consistent measurement regardless of who is completing the survey. Cronbach's alpha was used to determine the internal consistency of the CA; it was computed with a statistical analysis software provided to the researcher by the school administration. Reliability statistics was implemented on the entire sample. The output was a favorable alpha score. Reliability of the assessment was determined to be α =.76 for the 25-item assessment. Since the assessment was created using the test Item Specification for Grade 5 science, the content validity was the research method used to measure whether the test measured what the science standards.

The benchmarks are assigned a level of difficulty based on its "cognitive complexity" (Florida Department of Education Office of Assessment, 2012, p. 4). In creating the test items, the team used three levels of complexity: 10%-20% of the items on the assessment were low complexity, 60%-80% were moderate complexity, and 10%-20% were high complexity (Florida Department of Education, 2014); this ensured the reliability of the test. The Florida Department of Education Office of Assessment (2012) explained that the degree of complexity for the various questions assessed students' ability to "recall and recognize concepts, use informal methods of reasoning and problem-solving strategies, and engage in multiple steps and require the student to think in an abstract, sophisticated way" (p. 4).

The paper and pencil assessment consisted of 25 multiple-choice questions worth four points each and aligned to the science benchmarks in the unit. The test score is based on a scale of 100. The value of each item is 4 points. Florida's science results are reported in three ways: by scale scores, content area scores, and achievement levels. Thus, for the purpose of this study, the researcher only analyzed the achievement-level results. There are five performance test score achievement levels that indicate student performance. These levels are based on the grading scale score for the school district. Level 1, a score below 59, indicates that the students demonstrate an inadequate level of success with the challenging content of the standards. Level 2, a score of 60 to 69, indicates that the students demonstrate a below satisfactory level of success with the challenging content of the standards. Level 3, a score of 70 to 79, indicates that the students demonstrate a satisfactory level of success with the challenging content. Level 4, a score of 80 to 89, indicates that the students demonstrate an above satisfactory level of success with the challenging content of the standards. Level 5, a score of 90 to 100, indicates that the students demonstrate mastery of the most challenging content of the standards (Florida Department of Education Office of Assessment, 2013).

The classroom observation tool was used to generate qualitative data to answer Research Question 2, which focused on the implementation of science instruction with fidelity by the teachers as measured by the observation. Marzano's (2013) seven focus elements for classroom instruction were used to create a checklist with yes-or-no options and a comment section. Marzano argued that the following seven element descriptors have the greatest impact on student achievement: "identifying critical content, elaborating on new information, recording and representing knowledge, examining similarities and differences, examining errors in reasoning, revising knowledge, and engaging students in cognitively complex task involving hypothesis generation and testing" (Marzano, 2013, p. 4). The researcher used the observation form to observe teachers for one class period a week for every other week for eight consecutive weeks during science instruction.

The structured interviews (Appendix A) were used to gather data from the participants and generated qualitative data to answer Research Question 3, which focuses on the impact of the instructional design model on teachers' perceptions of their ability to teach science effectively. The structured interview explored the teachers' perceptions regarding the value of the instructional design model when used to teach Grade 5 science. The structured interview was created for this study and field tested with a panel of experts. As advised by Creswell (2014), the instrument was field tested twice: first by three school-based science coaches to ensure the logic, clarity, and structure of the instrument, and second with three persons similar to the research participants but who were not in the study to ensure that the instrument was clear, complete, and concise. The instrument was revised following the pilot test based on feedback from that panel to correct grammar mistakes and add a question to the post interview section regarding the teachers' perception of the data.

Procedures

This mixed methods study will determine whether using the instructional design model (Tyler, 1949) impacts science achievement, teachers' perceptions of their ability to teach science effectively using the model, and has any effect on science achievement. A convergent mixed methods design was used; in this type of design, the qualitative and quantitative data are collected in a lateral fashion, analyzed separately, and then merged together. This study took place over an eight-week period. In this study, students' test scores were used to test whether the instructional design model assists teachers in positively influencing the test scores for students at Local School A. The phenomenological component explored the teachers' lived experiences of new instructional strategies. The reason for collecting both quantitative and qualitative data is to determine whether teachers who utilized the instructional design model improved their students' science achievement scores. The science curriculum for the unit in which the teachers are using the instructional design model remained the same. The significant difference was the integration of hands-on science labs, collaborative structures, expanded use of predetermined instructional videos, and small group instruction.

During a weekly planning meeting, the teachers were given the option to officially participate in the study by the researcher and receive their participant letter (Consent Form) stating that the teacher understands the study and agrees to participate. The teachers' identities were confidential (Appendix C). At one of the weekly planning meetings, the researcher conducted a one-hour professional development meeting (Appendix D) for the teachers regarding the instructional design model and the research process. During the professional development, teachers gained knowledge regarding the instructional design model's components, teacher observation, and common planning expectations. The participants received materials on the instructional design model and the presentation. During a two-week period, the researcher interviewed the teachers and completed the pre-questions section of the structured interviews (Appendix A). After the two-week time frame, the teachers administered a pretest to the students on the standards that were covered during the eight-week duration of the study, which helped to address Research Question 1. The paper and pencil assessment consisted of 25 multiple-choice questions which were worth four points each and aligned to the science benchmarks in the unit. The test score was based on a scale of 100. The value of each item was 4 points.

The teachers attended weekly common planning and collaborative planning meetings to prepare and standardize their use of the enriched curriculum. The teachers taught a unit on forms of energy and earth space over an eight-week period using the Florida Statewide Science Standards. This science unit was determined based on the district's curriculum sequence and the estimated approval time of the IRB. In the event that the researcher had not received IRB approval from the district, the researcher would have delayed starting the next science unit until receiving IRB approval. The researcher observed each teacher every other week and completed the teacher observation form (Appendix B) following every observation. After the unit was completed, the students were given a post-test and the results were compared the pre-test. The researcher interviewed the teachers and complete the post-questions section of the structured interview (Appendix A).

Quantitative data collection. The quantitative data collection occurred after the students completed the 25-item pre- and post-tests. The test score was based on a scale of 100. The value of each item was 4 points. The pre-assessment test score was utilized to determine the students' baseline content knowledge before instruction. The post-test scores were used to determine the students' science content growth. The results were compared to last year's scores to determine whether using the instructional design model significantly impacted post-test results. This data were ex-post facto data and were provided to the researcher by the school administration. Ex post facto is described as what is done afterwards because the data are already collected by the school (Simon & Goes, 2013). Simon and Goes (2013) pointed out that ex post facto research is ideal for conducting social research when is not possible or acceptable to manipulate the characteristics of human participants. This type of data is an alternative to performing experimental research with children and can be used to test hypotheses about cause-and-effect or correlational relationships. Ex post facto research uses data already collected, but not necessarily amassed for research purposes (Simon & Goes, 2013).

Qualitative data collection. At the beginning and the completion of the eight-week science unit, the teachers participated in structured interviews regarding their perceptions of the value of the instructional design model. The researcher obtained permission from each participant (Appendix C) to record the interview. The researcher used the structured interview questions (Appendix A) for each teacher's interview. The researcher thanked each participant for their time and participation in the study. After the interview, the researcher transcribed the recorded interview and provided the teachers with a hard copy to review for accuracy (member checking). Once the teacher has agreed that the transcribed information is correct, then the researcher and the teacher verbally agreed that the document was approved for data analysis. The researcher observed the teachers every other week for the eight-week period, the five teachers were observed by the researcher for a complete class period. The researcher documented the teachers' actions based on the instructional strategies used by the teacher.

Quantitative data analysis. In this study, a multiple-choice assessment was used as the instrument to collect pre- and post-test science achievement scores to answer Research Question 1 and to determine the impact of the instructional design model on science achievement post-test results. Descriptive statistics were calculated and analyses were conducted using IBM SPSS Statistics v 25. Frequencies, means, and standard deviations were calculated for demographic variables and assessment scores.

R1: What impact will the use of the instructional design model have on Grade 5 students' science post-test results?

$H_{01:}$ The instructional design model will have no significant difference on the Grade 5 science post-test results.

H_1: The instructional design model will have a significant difference on the Grade 5 science post-test results.

The results included two sets of analyses. The first was a one sample t-test to determine significant differences between the pre-test and post-test for the 2018-2019 year. Then, a one sample t-test was used to determine whether there is a significant difference between the post-test scores between 2017-2018 scores and 2018-2019 scores.

Qualitative data analysis. In this study, the teachers were observed every other week. The data were collected and analyzed. The observations were used to determine whether the teachers followed the models protocol while teaching. The responses to the structured interviews were analyzed to determine the teachers' perceptions of the impact of the instructional design model on their instruction and the students' achievement. Following the taped interviews, the teachers received a hard copy of their taped interview to review and make any changes. This is referred to as a member check. Once the member checking was completed, the researcher read the transcripts. When reading the transcripts, the research looked for patterns of responses (key words, repeated phrases, similar statements). These words and phrases were analyzed to determine primary and secondary themes from the teachers' responses to the interview questions.

Data integration. The school administered a multiple choice, 25-item pre-test to the Grade 5 students. The teachers participated in an interview, received professional development on the instructional design model, attended common planning meetings to develop lessons, delivered the lessons, and participated in a post interview. The teachers taught an eight-week unit and each teacher was observed every other week for one class period. After the eight-week period, the teacher administered the post-test to the students; is the post-test was the same test as the pre-test. A convergent mixed methods design was used; in order to collect data in this type of design, the qualitative and quantitative data were collected in a lateral fashion, analyzed separately, and then merged together.

Limitations

Limitations are "constraints that are largely beyond your control but could affect the study outcome" (Simon & Goes, 2013, p. 2). The limitations regarding this study are three-fold. The first limitation was sample size. The sample size in this study was very small, thus limiting the generalizability of the research findings. This study only involved five teachers in one school and the data from two years of 2017-2018 and 2018-2019 pre- and post-tests. This limits the generalizability of the findings. The second limitation was each teacher's classroom experience. In this study, the five teachers had a variety of experiences teaching science, which may have resulted in their inability to implement the instructional design model with fidelity. The teachers developed the lesson plans together in common planning; however, each teacher’s style of teaching is different based on the teacher’s experiences. The third limitation was the participants’ socio-economic background. The participants work at a Title 1 school and may not have sufficient resources outside of school. Furthermore, there may be some social and economic factors that negatively impact the study that is beyond the researcher’s control.

Chapter 4: Results

This chapter presents the results derived from the data collection. The chapter is organized by research questions, data collection, data protection, description of the sample, coding process, and emergent themes. The purpose of this study was to determine whether the instructional design model would improve science achievement. Elementary science test results in the schools that participated in this study indicated a science achievement deficiency and a lack of knowledge on how to teach science utilizing the instructional design model (Blank, 2012; House, 2012; Kaezmpour, 2013; Ross & Carier, 2015), The researcher focused on Grade 5 students who were performing low on science achievement assessments and their teachers. The study was guided by the following research questions:

R1: What impact will the use of the instructional design model have on Grade 5 students' science post-test results?

$H_{01:}$ The instructional design model will have no significant difference on the Grade 5 science post-test results.

H_1: The instructional design model will have a significant difference on the Grade 5 science post-test results.

R2: How has the instructional design model influenced a student's ability to understand and learn the science concepts being taught as observed and measured using a validated structured classroom observation form?

R3: How has the instructional design model influenced a teacher's perceptions of student learning when reflecting on their previous teaching approach?

Subquestion 1: Did the teacher's perceptions translate into improved post-test results?

Data Collection

Quantitative data collection. The quantitative data were collected using a pre- and post-test consisting of 25 multiple-choice questions worth four points each and aligned to the science benchmarks in the specific unit of study. Prior to any data collection, an informed consent form was signed by the students' parents and returned to the school (Appendix E). The pre-test score was used to determine the students' baseline content knowledge before the instruction. The post-test scores were used to determine the students' science content growth. The results were compared to the elementary school's scores to determine whether using the instructional design model significantly affected post-test results.

Qualitative data collection. The researcher identified 5 fifth grade science teachers from a Title 1 school. Prior to any data collection, an informed consent form was obtained (Appendix C) from each teacher who participated in the study. Teachers were told they would be asked to participate in a recorded interview. The teachers participated in structured interviews (Appendix A) that were designed to obtain their perceptions of the value of the instructional design model at the beginning and the end of the eight-week unit. After the interview was conducted, the researcher transcribed the recorded interview and provided the teachers with a hard copy to review for accuracy. Creswell (2015) referred to this process as "member checking" (p. 259). Using this process, all the teachers agreed that the transcribed information was correct and the researcher then began to analyze the data. The researcher also observed the teachers for a class period of

45 minutes every other week over an eight-week period. The researcher documented the teachers' actions on the observation form based on the areas that are "research based instructional strategies that can be used in the classroom to enhance student achievement" (Marzano, Boogren, Heflebower, Kanold-McIntyre, & Pickering, 2012, p. 1). The seven focus areas of instruction in the observation tool are identifying critical content, elaborating on new information, recording and representing knowledge, examining similarities and differences, examining errors in reasoning, reviving knowledge, and engaging students in cognitively complex tasks that involve hypothesis generating and testing.

Data Protection

The participants' responses were anonymous. Information acquired in this research study was handled in a confidential manner, within the limits of the law. The classroom observations and interviews did not include teacher names. Each teacher was given a number for the classroom observations and an assigned letter was provided to code the participants' names for confidentiality on all documents. All confidential data were kept securely in the researcher's home in a locked file cabinet. The risk to the participants was minimal. In order to ensure data security, the researcher utilized the following measures: the study data and audio files were stored on a password protected external hard drive and all paper copies and handwritten notes were kept in a locked file cabinet accessible only to the researcher. All data will be kept for 36 months from the end of the study and destroyed after that time by the researcher by shredding the paper copies of documents and deleting all files (including audio) from the hard drive.

Description of the Sample

The sample size was 60 Grade 5 students at the target school. The students received science instruction and participated in the pre- and post-test. The original sample was 93 students; however, the researcher was only able to obtain approval for 60 students. Five Grade 5 teachers at the target school made up the population. The population of teachers have a wide range of demographics. The ethnic makeup of the teachers included two Black females, one Hispanic female, one Black male, and one White male. The teachers had a variety of teaching experiences; four taught less than five years, one taught less than ten years, and one taught more than 12 years. Table 7 displays the demographic data for all participants.

Table 7

Teacher Participant Demographics

Participant Letter	Gender	Ethnicity	Age Range	Educational Level Degree	Years Teaching
A	Male	Black	30-39	Bachelors	14
B	Female	Black	30-39	Bachelors	2
C	Male	White	20-29	Bachelors	1
D	Female	Black	40-49	Masters	2
E	Female	Hispanic	20-29	Bachelors	6

Quantitative Findings

The first research question was, “What impact will the use of the instructional design model have on Grade 5 students’ science post-test results?” The null hypothesis stated, “The Instructional Design Model will have no significant difference on the Grade 5 science post-test results.”

A comparison of the mean post-scores was conducted to compare 2017-2018 school science scores to 2018-2019 school science scores from teachers utilizing the instructional design model have on Grade 5 students' taking the District CA. The mean scores were *M* = 45.22 and SD = 11.70 for 2017-2018 and *M* = 58.60 and SD = 15.018 for 2018-2019. The differences were statistically significant, *t*(59) = 30.22, p = .000, two-tails; equal variances assumed since the population of students are from the same school district (Table 8). Therefore, the null hypothesis was rejected as a significant difference was found between students' post-test scores in the academic year the academic 2017-2018 and 2018-2019, when the teachers used the instructional design model.

Table 8

One-Sample Statistics

Year	N	*M*	SD	Std. Error Mean
2017-2018	60	45.22	11.70	1.510
2018 -2019	60	58.60	15.01	1.939

Table 9

One-Sample Test

Test=0

Year	*t*	*df*	Sig (2-tailed)	*M*	95% Confidence interval of the Difference	
					Lower	Upper
2017-2018	29.93	59	.000	45.21	42.19	48.24
2018-2019	30.22	59	.000	58.60	54.72	62.48

Qualitative Findings

The second research question asked, "How has the instructional design model influenced a student's ability to understand and learn the science concepts being taught as observed and measured using a validated structured classroom observation form?" The observation form measured the implementation of science instruction. The researcher used Marzano's (2013) seven element descriptions because they help students with learning the content: "identifying critical content, elaborating on new information, recording and representing knowledge, examining similarities and differences, examining errors in reasoning, revising knowledge, and engaging students in cognitively complex tasks involving hypothesis generation and testing" (Marzano, 2013, p. 4). The researcher used the observation form to observe teachers for one class period a week for every other week for four weeks during science instruction.

To answer the second research question, the researcher observed the teachers and the related data acquired from the observations, which is presented in figure form. These figures represent an average of the data generated by the five teachers. The researcher chose not to present individual teacher observational findings but rather present the data in seven figures. The individual teacher observations did not indicate a wide range of difference amongst the teachers based on their demographics..

Identifying critical content. The teachers identified the critical content that the students needed to master by the end of the lesson, which helped students to focus on the goal of the lesson (Marzano & Toth, 2014; Senn, Rutherford, & Marzano, 2014). The first area of identifying critical content involved an opportunity for students to respond and share their understanding of the critical content with the teacher or peers. The use of this approach or concept was observed during 5 of the 10 classroom observations (50%).

The second area of identifying critical content involved the teacher providing the students with key points that were critical for students to learn. The use of this strategy was observed during 10 of the 10 classroom observations (100%). The third area of identifying critical content involved the teacher monitoring the students to determine whether the students understood the critical content. The use of this approach was observed during 7 of the 10 classroom observations (70%).

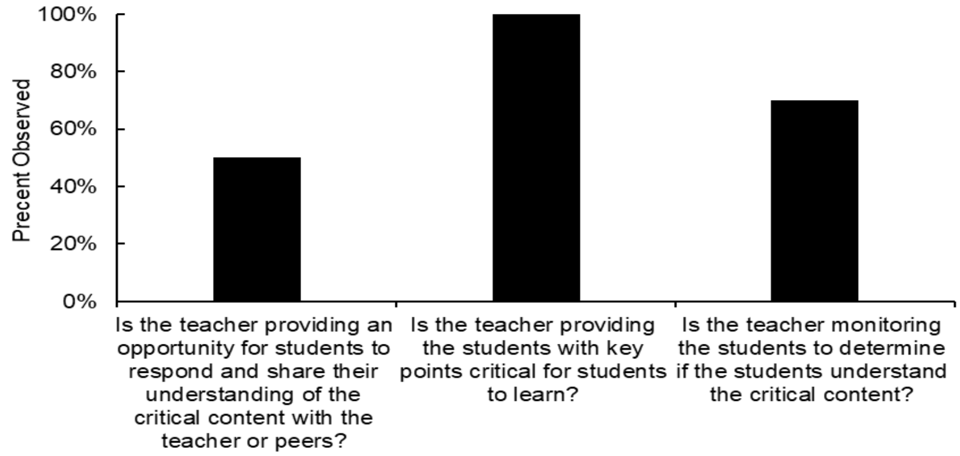

Figure 1. Classroom observations section 1.

Elaborating on new information. The teacher helps students elaborate on new content by asking questions about the information and requiring students to provide evidence on what was taught (Marzano et al., 2013). The first component of elaborating on new information is the teacher providing an opportunity for students to make a connection between the learning objectives and their own experiences. The use of this strategy was observed during 5 of the 10 classroom observations (50%). The second component of elaborating on new information involves the teacher facilitating organized collaboration among the students. This approach was observed during 10 of the 10 classroom observations (100%). The third component of elaborating on new information involved the teacher monitoring the students to determine whether the students could elaborate on new information. The use of this component was observed during 7 of the 10 classroom observations (70%).

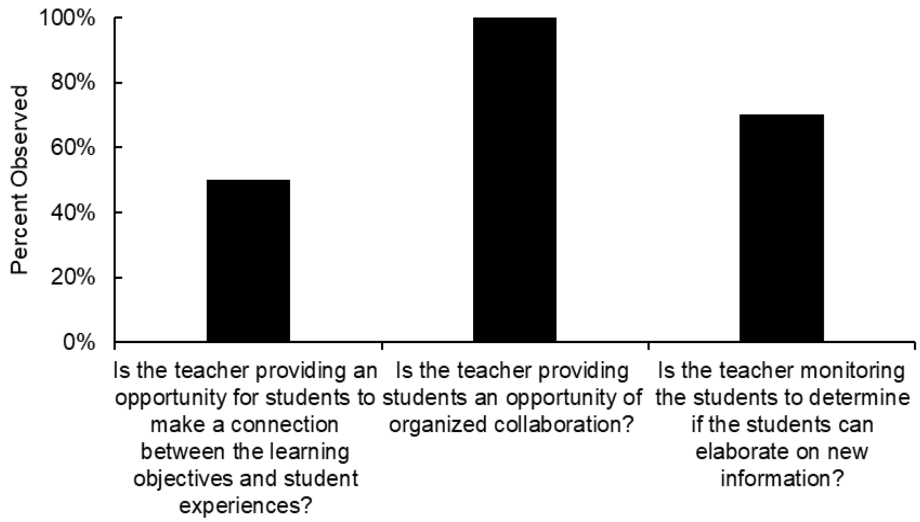

Figure 2. Classroom observations section 2.

Recording and representing knowledge. Teachers assist students in the classroom by helping them organize and summarize content through the process of recording and representing knowledge (Schmidt & Marzano, 2015a). In the first area of recording and representing knowledge, the teacher provided intentional learning experiences for the students to record and represent knowledge. The use of this approach was observed during 7 of the 10 classroom observations (70%). The second area of recording and representing knowledge is where the teacher monitored the students as they recorded and represented new knowledge. The use of this area was observed during 9 of the 10 classroom observations (90%). The third area of recording and representing knowledge had the teacher providing the students with a strategy to record and represent knowledge. The use of this area was observed during 8 of the 10 classroom observations (80%).

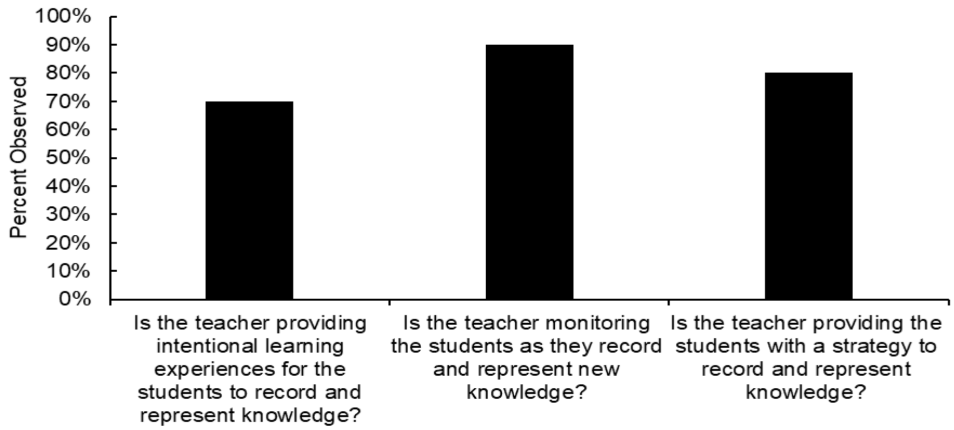

Figure 3. Classroom observations section 3.

Examining similarities and differences. According to West and Marzano, (2015) teachers assist students with examining similarities and differences by "deepening their understanding of the content knowledge but also enhance their long-term retention and problem-solving abilities related to critical content" (p. 5). The first area of examining similarities and differences was where the teacher provided intentional learning experiences for the students to examine similarities and differences. The use of this area was observed during 9 of the 10 classroom observations (90%). The second area of examining similarities and differences involved the teacher providing an opportunity for the students to make connections with the topic. The use of this area was observed during 7 of the 10 classroom observations (70%). The third area of examining similarities and differences was illustrated when the teacher asked students to explain their thinking or to revise their comparisons. The use of this area was observed during 8 of the 10 classroom observations (80%).

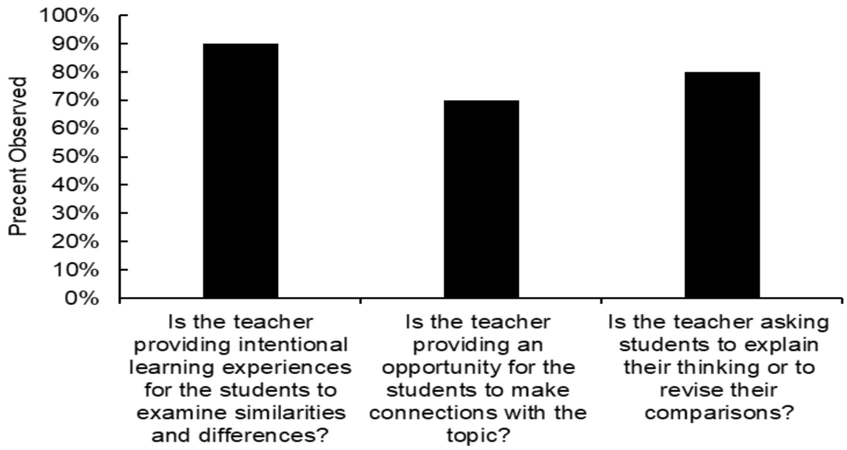

Figure 4. Classroom observations section 4.

Examining errors in reasoning. Teachers help students with their own thinking process by examining errors in reasoning through class discussions and content text (Marzano & Toth, 2014; Ocasio & Marzano, 2015). In the first area of examining errors in reasoning, the teacher provides intentional learning experiences for the students to examine errors in reasoning. The use of this area was observed during 10 of the 10 classroom observations (100%). The second area of examining errors in reasoning involves the teacher facilitating organized collaboration among students. The use of this area was observed during 9 of the 10 classroom observations (90%). The third area of examining errors in reasoning involves the teacher monitoring the students to determine whether the students can examine their errors in reasoning using evidence from their science text. The use of this area was observed during 8 of the 10 classroom observations (80%).

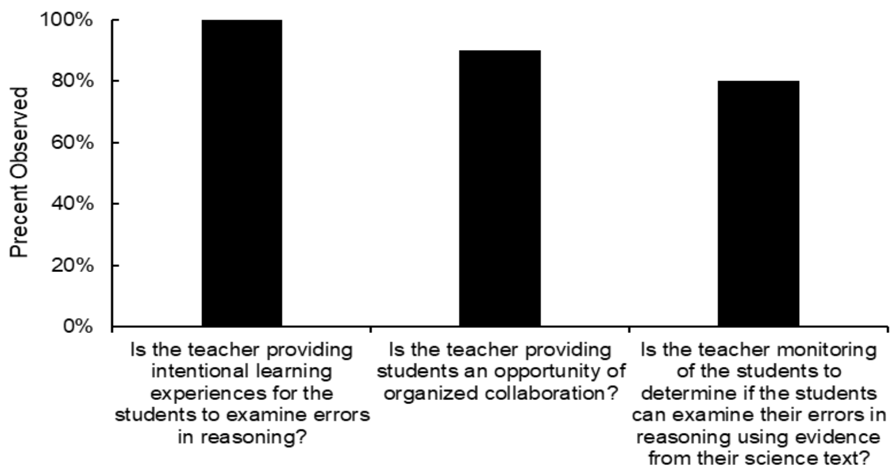

Figure 5. Classroom observations section 5.

Revising knowledge. Schmidt and Marzano (2015b) stated that "revising knowledge to help students examine their deeper understanding of critical content … has the potential not only to deepen their content knowledge but also enhance their memory and problem-solving abilities related to critical content" (p. 5). In the first area of revising knowledge, the teacher provides intentional learning experiences for the students to revise knowledge. The use of this area was observed during 9 of the 10 classroom observations (90%). The second area of revising knowledge has the teacher providing an opportunity for the students to use technology in revising their knowledge. The use of this area was observed during 5 of the 10 classroom observations (50%).

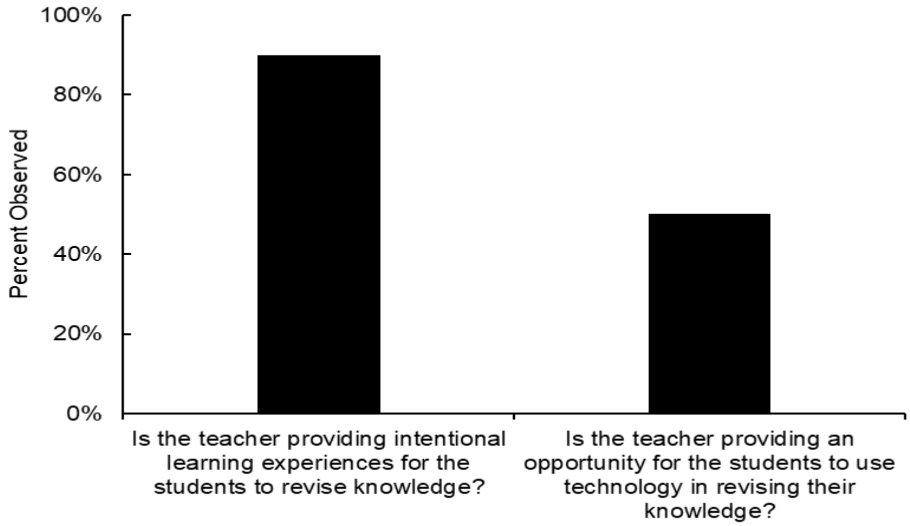

Figure 6. Classroom observations section 6.

Engaging students in cognitively complex task involving hypothesis generating and testing. In this strategy, the teacher assists students with cognitively complex tasks by encouraging students to produce and support claims based on the activity through the use of decision making, problem solving, experiments, or observations (Marzano & Toth, 2014; Senn & Marzano, 2015). The first component of this strategy involves the teacher providing intentional learning experiences to the students. The use of this component was observed during 5 of the 10 classroom observations (50%). The second component of this strategy involves the teacher providing an opportunity for the students to have science rich discussions. The use of this strategy was observed during 8 of the 10 classroom observations (80%). The third component of this strategy involves the teacher monitoring the students to determine whether the students are actively generating and testing hypotheses. The use of this component was observed during 5 of the 10 classroom observations (50%).

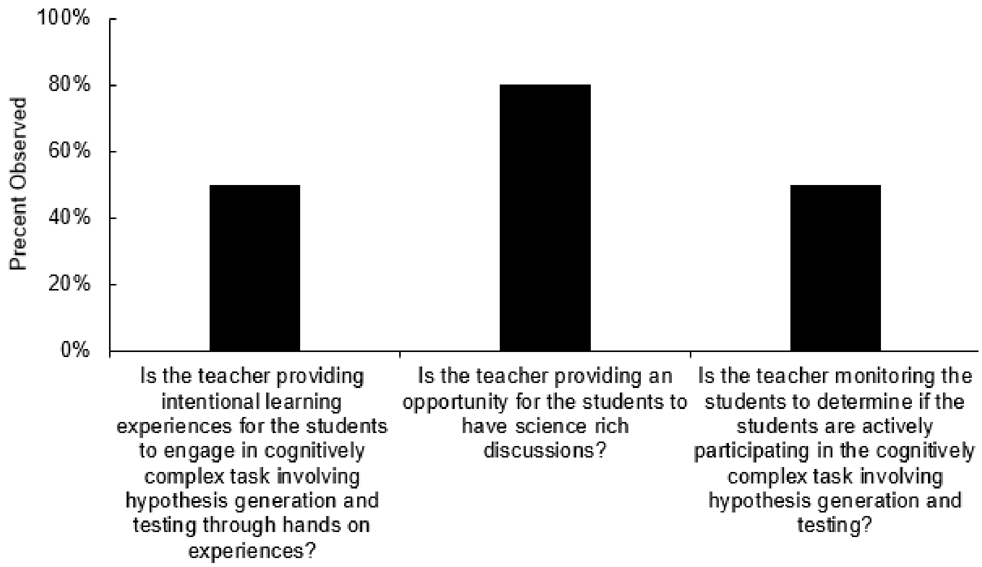

Figure 7. Classroom observations section 7.

The third research question asked, “How has the instructional design model influenced a teacher’s perceptions of student learning when reflecting on their previous teaching approach?” Subquestion 1 was “Did the teacher’s perceptions translate into improved post-test results?” To answer these questions, the researcher conducted pre and post interviews with the teachers. The interviews were transcribed, and the researcher reviewed the transcriptions for patterns of responses (key words, repeated phrases, and/or similar statements). The researcher included selected answers that assisted in generating the themes based on the coding process.

Coding Process

The researcher interviewed five participants and collected data through digital recordings and manual notes. The researcher analyzed and coded the responses. “Coding is the process of segmenting and labeling text to form descriptions and broad themes in the data” (Creswell, 2015, p. 242). In the coding process, the transcriptions of the five participants were recorded in Microsoft Word. The researcher examined the entire data set by looking for repeated comments, coding the comments, and compiling them into a single Microsoft Excel spreadsheet. The researcher analyzed the statements and color coded the information that was in Microsoft Excel. Then the researcher determined five themes based on the repeated comments. It was beneficial to use coding in this research because it allowed the researcher to compile themes as recounted by participants when expressing their viewpoints regarding each question (Miles, Huberman, & Saldaäna, 2014).

Emergent Themes

Emergent themes are inductive approaches to qualitative research and are derived from real world experiences (Pietkiewicz & Smith, 2014). The researcher recorded patterns from the comments from the teacher's pre and post interviews. Maguire and Delahunt (2017), stated “the goal of a thematic analysis is to identify themes, i.e. patterns in the data that are important or interesting, and use these themes to address the research or say something about an issue” (p. 3353). The researcher identified five themes. One of the themes was generated from the pre-interview data while than other four themes were generated from the post-interview data.

Theme 1. Lack of experience with the instructional design model (pre-interview). Participant B stated, “I believe I don’t have any experience with that.” Participant D stated,

> I have no experience with instructional design model. I’m not even sure what that is. But I’m looking here and I’m seeing ‘generating objectives.’ I do have experiences with that. Like when I’m doing lesson plans, you put an objective. The object of the lesson is for the student to be able to do whatever the lesson

> subject is. And hopefully at the end of the lesson, they understand. If not, at least they're able to explain the essential question. If we have an essential question. The object of that is for them to at least understand some part of the lesson.

Theme 2. The strength of the instructional design model is the organization of activities (post interview). Participant A stated,

> I love how it is organized. It helps to keep us on track. First you have to do the-the, the planning. You have to plan it properly, and you have to make sure you research the content. So there's no… there's no way you're going to stand in front of your class as a teacher and not know what to teach a student, because with this model, you have to plan and plan. Also, like that it helps us to… to make sure that the content standard we need are the ones that properly. Research break it down, you have to deconstruct…deconstruct your standard, know the activities that go with it, and plan for your students. we teach for the students and also help to prepare the students in a timely matter. So, I like that about it.

Participant C stated,

> I think it's nice for the students because it's so structured, they know kind of how a lesson… is going to look before they've seen it. Like they-they know what to expect so there's not really any, uhm, curve balls thrown at them to kind of confuse them. It's very structured, and that's useful for me and them. And we organize the activities, uhm, in collaborative groups for students.

Theme 3. The challenge of the instructional design model is the lack of time to plan and execute activities (post-interview). Participant D stated,

> time is our biggest factor. The time it takes to create those lesson plans, and the time it takes to instruct—depending on the length of the lesson, or how the students are grasping it. And it's always my hope that they get what is being presented. So that's a challenge. And, uh usually we don't have enough time… depending on the length of the lesson. That's the biggest challenge.

Participant E stated,

> I would say the time management piece of it cause it was a lot of content, in trying to get everything, excuse me, including like all of the activities, the reading, the videos, it was-the-the time and, you know, having live kids, and having to manage their behaviors and, you know, certain things that come up with, you know, schedule issues or whatever.

Theme 4. Increase in data (post interview) positive response based on increase test scores. Participant B observed in her students

> a lot of growth … between their … pre- and their post-test, so I believe that using this instructional model did benefit, did benefit the students a lot, because of the growth that I saw. For instance, one growth that I saw … my assessment data showed that a student went from 20 to 68 … which I know that had to do a lot with the instructional model.

Participant E stated,

> looking at my data, I-I definitely see growth. And, I know for a fact, comparing the-the pre-assessment to the post-assessment, obviously the-the instructional design model had a lot to do with their growth, uhm, otherwise they wouldn't have had anything to grow from, or with. They wouldn't have had the tools—

> excuse me—the tools to be able to, to improve, basically, to be able to understand, the content that was on the test.

Theme 5. The teachers would recommend the instructional design model to others (post-interview). Participant A stated,

> Definitely I would recommend it. It-it … it removes the ambiguity in teaching in terms of you going to your class not knowing what to do. You're going there prepared because you are going to use this model. And also, as I said earlier, it ap-it expose the, every different-it caters to all the different learning styles in your classroom. You have some persons who are-some students who are learners. It-it allows for that. It allows for visual learners. It allows for, allows for auditory learners. So, I do love it-I like it.

Participant E stated,

> because it was structured in such a way that they were able to be hands-on, they were able to, get the-the knowledge from the reading, from the literature, they were able to, watch the videos and it all had to, basic-it all blended in together. And, this instructional design model, actually-w-you know, having the time being one of the things that we struggled with, it was laid out pretty well, uhm, where another teacher could like jump and-and use it like right away. It wouldn't have to be something that took a really long time to adapt to.

Interview Questions and Selected Responses

The teachers participated in pre and post structured interviews. The interviews were analyzed to determine the teachers' perceptions of the instructional design model's effect on their instruction and the students' achievement. The questions and selected responses are included below to give the reader an overall synopsis of the interview responses.

What is your experience with the instructional design model in regard to generating objectives? (pre-interview). Participant A stated, “I-I-I don’t know. I-I-I don’t-I don’t know this model.” Participant B stated, “I believe I don’t have any experience with that.” Participant C stated,

> my understanding was there was like five ‘Es’ or where you’re using standards and kind of breaking those apart looking at verbs, trying to see what students should be able to … So, we’re generating objectives based off of, verbiage and a standard.

What is your experience with the instructional design model in regard selecting activities? (pre-interview). Participant B stated, “For my science lessons? For labs, I pretty much try to make sure they go with our standards. And, I like a lot of hands-on activities that they can use … so they can better understand it.” Participant C stated,

> when we’re selecting activities, what we should be doing is we should hopefully be selecting activities that move us towards completing those activities… or objectives that like we kind of previously just stated. Like, the activities should be building us towards the bigger—the bigger objective so we can complete it.

Participant D stated,

> I’m not sure what the instructional design model is. With selecting activities, as, as pertaining to the lesson. Whatever the lesson is, we need to select activities that coincide with the lesson; hands-on, to give the students a better understanding. And I think activities are fun.

What is your experience with the instructional design model in regard organizing and sequencing activities? (pre-interview). Participant A stated, “Again, I don’t know this model.” Participant D stated,

> I know I sound like a s-broken record. With this first portion of the question, the instructional design model, I have no idea as to what that is. I really don’t. I’m sorry, but I don’t. But in regard to organizing and sequencing activities, again I’m thinking that goes in with whatever it is that I’m instructing with the lesson. Organizing that it would fall in place, if, whatever it is that I’m teaching, the activity should follow or should come before it so that they would understand. It must be in sequential order.

Participant E stated,

> again like I’ve worked with, my team in the past and science coaches and STEM coaches to, do pacing and-and that type of thing, and scheduling of activities that align with the content, but, yeah that’s-that’s as far as I’ve done with organizing and sequencing of activities.

What is your experience with the instructional design model in regard evaluating? (pre-interview). Participant B stated, “I’m not sure.” Participant C stated,

> I was trying to remember these two vocabulary terms during this interview. I know you got like two types of assessment? And I’m forgetting their names right now. But there’s like your non-kind of test-based, that you’re just kind of collecting data… on, you’re kind of seeing what the kids know, seeing what they’re learning, and you’re using that to inform your instruction… for your testing data? Which I’m wish I—I’m wishing I remembered those two words right

> now. But uhm, I know there's you know, there… you're evaluating where you're just kind of seeing what the kids are learning, seeing what they're doing. It's not really kind of a grade; you're just seeing that they're participating—that they're learning. And then you've got your graded assessments which would be like your tests, your quizzes, things like that. Which don't really inform your instruction because that's kind of the task in mind. That's the final thing. Okay.

Participant D stated,

> Let's just skip to the evaluating part. Again, the instructional design model, no clue. Evaluating I-I'm thinking of, rubrics … as opposed to … not "as opposed to," but rubrics when checking the students' work. That's what I use to evaluate, as well as informal assessments: walking around, evaluating, seeing how they're doing. That's my idea of evaluating.

What was your understanding of the instructional design model? (pre-interview). Participant A stated, "I have no idea what that is. I'd have to research that." Participant C stated, "I'm not sure what it actually is." Participant D stated, "I have no understanding of that. No clue." Participant E stated, "Not at all. Not at all."

In your opinion, what are the strengths of the instructional design model? (post-interview). Participant A stated,

> I love how it is organized. It helps to keep us on track. First you have to do the-the, the planning. You have to plan it properly, and you have to make sure you research the content. So there's no … there's no way you're going to stand in front of your class as a teacher and not know what to teach a student, because with this model, you have to plan and plan properly. Research, break it down, you

> have to deconstruct … deconstruct your standard, know the activities that go with it, and plan for your students. I also like that it helps us to … to make sure that the content standard we need are the ones that we teach for the students and also help to prepare the students in a timely matter. So, I like that about it.

Participant B stated, “I believe the strengths of the-the … the instructional design model are basically, the actual activities they participate in. The last that we did, that experience that those students needed, they were able to get it through those activities.” Participant D stated,

> since we’ve had our training, and what we always do, we see, I think the strengths of this is to see what works and what doesn’t. Planning together the lesson plans, hands-on, working with the activities to see how it’s gonna look in the classroom. Also, making sure that we understand on how to present it … and, actually understand the science concepts I’m talking about. And to make sure that we present it well to the students. And, we … we also get ideas from the discussions to see what’ll best work for our group. And these hands-on lessons actually are aligned to the objectives and standards, when we plan these lessons together. And it really helps us with organizations of the activities.

Participant E stated,

> I would say that the organization of the activities, uhm, and how they align to the standards helped to basically organize, us teachers with the content to be able to teach the students, uhm, effectively and to be able to get all of the instruction in-in … in organized and timely manner.

What are the challenges of using the instructional design model? (post-interview). Participant A stated,

> with this level of organization and-and planning, it does take time. It does take time, so you have to devote a lot of time to it, and you have to make sure that you are doing exactly what you need, uhm, in the organization often being time-consuming, not only with the planning, but also with the execution, you have to make sure that you are on schedule, you are hitting the-u-using your timer, and getting things done because distractions, special behavioral problems can cause some delay with it. But, if you're organized and you have everything prepared, your procedures and all that you're planning works-it can work just the same. But it just … can be time-consuming.

Participant C stated,

> one of the challenges of the instructional design model is because it's so structured, and you have to go step by step by step, sometimes that can lead to, uh, a decrease, I guess in time. Or you're spending too much time on a step and it kind of … pushes you behind, and it-it's hard to make up time because it's so structured, uh, if you fall behind, there's really no areas where you can make up that time. You can't really cut out a piece of the lesson because there-it's also important for the students.

Participant E stated,

> I would say the time management piece of it 'cause it was a lot of content, in trying to get everything, excuse me, including like all of the activities, the reading, the videos, it was-the-the time and, you know, having live kids, and

> having to manage their behaviors and, you know, certain things that come up with, you know, schedule issues or whatever.

Based on your students' pre and post assessment data do you think the instructional design model has anything to do with the scores? (post-interview). Participant A stated,

> Oh, yes! Oh, yes. It does. On the pre-on the pre-test, I realize where one of my students scored a 52 that-using this model that scored-that s-same student on the post-test scored a 76. I can also speak of others-uhm, there was a 64 for one student, and there was uh, a 76. This model does allow you to cater to just about every different learning style because, you are using reading material, you are blending it with videos, you are doing all these things, so you are catering to all the students. And I've seen where they have improved.

Participant C stated, "Yes. While looking at the data, I can see a considerable amount of growth for the students that, uh, properly follow the instructional design model. And I can see their scores raising." Participant D stated,

> Of course! … Prior to the knowledge of what was, given, I'm looking at the data and I've had one student who, before the instructional design model was taught, got a four. After that … they got a 68. Now … that is a no-brainer. Yes, of course, the post-assessment did help. And then I have another student who got a 32, prior, and then after, an 84. Yeah. I'd say that, the post-assessment … has a whole lot to do with the scores.

Would you recommend this instructional design model to other science teachers? Why? Why not? (post-interview). Participant B stated,

> Actually, I would. Because not only did I see the growth in the data-the assessment that we had, but I also seen the-I like the organization of it. I like that the-the objectives align with the activities they had to do … I overall I just love the experience that the students were able to get. The planning together, the hands-on lesson was very it-it benefited me also because I was even more familiar with what we had to do and how to align it, so I did learn a lot from it, and then the students also benefited, too.

Participant D stated,

> Yes, I would. … Why? Alright, first we identify the learning goals and objectives, right? Then we create the lesson plans. And those lesson plans align to the goals, which helps us determine how we organize … this, right? And, … based on what we see, this instructional design, without it I can't imagine how I would actually teach it and how the students would get the information. And after that, we also assess them to see if they've mastered or understood what we've taught. So, I would definitely recommend this because again going back to the data, after we've given the information, uhm, whatever it is that we've taught, we see an improvement. So, this instructional design model I think is-is really good.

Participant E stated,

> I would, uhm, because it was structured in such a way that they were able to be hands-on, they were able to, get the-the knowledge from the reading, from the literature, they were able to, watch the videos and it all had to, basic-it all blended in together. And, this instructional design model, actually-w-you know, having the time being one of the things that we struggled with, it was laid out pretty well,

> where another teacher could like jump and-and use it like right away. It wouldn't have to be something that took a really long time to adapt to.

Evidence of Trustworthiness

Credibility. According to Murawska and Walker (2017), "credibility is the parallel term used to describe a similar notion for qualitative data" (p. 279). To help facilitate a deeper understanding of the data, written transcriptions of the interviews were provided to the participants so they could check their authenticity through member checking. Member checking was used to ensure this study's credibility by allowing interviewees to check the accuracy of the transcripts and to acknowledge that it is a clear depiction of their responses.

Transferability. Willig (2013) expressed that it is important to have thick and rich descriptions of participants' perceptions and experiences in a study. Transferability of the data was accomplished via audio recording, interview transcriptions, and researcher's notes from the open-ended pre and post interviews. The researcher used the words from the interviews to develop a thick description of the qualitative component of this mixed study phenomena from the Grade 5 teachers. The thick descriptions offered interconnected details and will allow the readers to determine whether the results can be transferred to other settings (Creswell, 2013; Creswell, 2014).

Dependability. According to Marshall and Rossman (2011), dependable findings that are consistent and can be repeated. The chairperson and committee member share extensive experience in mixed methods research and provided feedback regarding the study, thereby providing an ongoing dependability audit.

Confirmability Reporting qualitative findings through narrative phenomenology highlights the development of key themes, statements, and meaning units that bring light to the essence of the phenomena (Creswell, 2016). Seidman (2013) expressed that it is important for the participants to give the details of experiences from their stream of consciousness through the interview process. In this process, the teacher reviewed the participants' responses and the researcher's notes to ensure their responses were correct to reach confirmability. Also, during the pre and post interviews, the researcher continuously checked for the intended meaning of the participants.

Summary of the Findings

This chapter covered the findings from teacher observations, student data, and teacher interviews to determine whether the instructional design model would improve science achievement. Chapter 5 includes a summary and discussion of results, conclusion and summaries, findings linked to relevant research, implications of the findings, limitations, recommendations for further research, and a chapter summary.

Chapter 5: Discussion

Introduction

This study was designed to determine whether the instructional design model would improve science achievement among 60 Grade 5 students. The theoretical framework applied to this study was developed by Ralph Tyler in 1949. Tyler's instructional design model guided teachers to look differently at teaching and learning. This model assisted teachers in developing lessons that used the instructional design model producing objectives that reflect their classroom goals, impacting curriculum, and increasing the understanding of science concepts.

In this study, multiple-choice assessments were administered to students at the start and end of their courses to collect science achievement data to answer Research Question 1. The collected data illustrated the impact of the instructional design model on students' science achievement. A classroom observation tool was used to generate qualitative data to answer Research Question 2, which was focused on the implementation of science instruction with fidelity by the teachers as measured by the observation. Lastly, a classroom-structured interview was used to gather data from the participants and generate qualitative data to answer Research Question 3, which focused on the impact of the instructional design model on teachers' perceptions of their ability to teach science effectively.

Quantitative Results

The first research question investigated the impact the instructional design model had on Grade 5 students' science post-test results. An independent sample t-test was conducted to find the statistical difference between post-test results from the 2017-2018 and 2018-2019 school years. The test yielded a statistical difference between the post-test scores from the 2017-2018 and 2018-2019 school years. In 2017-2018, the instructional design model was not utilized, and in 2018-2019 the instructional design model was utilized 100% of the time. The mean scores were M = 45.22 and SD = 11.70 for 2017-2018 and M = 58.60 and SD = 15.018 for 2018-2019 academic years. The results of the t-test provided statistical evidence that the instructional design model increased science scores $t(59) = 30.22$, $p = .000$, two-tails; equal variances assumed.

Qualitative Results

The second research question investigated the instructional design model's influence on a student's ability to understand and learn the science concepts being taught. The students' abilities were observed and measured using a validated structured classroom observation. The emergent themes provided evidence to support that students understood and learned the concepts being taught in the classrooms.

The third research question investigated the influence of the instructional design model on a teacher's perceptions of student learning when reflecting on their previous teacher approach. The researcher explored the teachers' experiences of teaching new instructional strategies. Based on the teacher interviews, 5 out of 5 teachers (100%) agreed that the instructional design model contributed to student learning and increased science achievement among their students.

Conclusions and Summaries

The purpose of this research study was to determine whether the instructional design model would improve science achievement. In addition, the researcher wanted to understand the teachers' perceptions. The data analysis revealed that the instructional design model had a significant impact on Grade 5 science achievement. The participants' responses aligned with theories that supported the foundation of the research study (Buaraphan, 2011; Cotabish, Dailey, Robinson, and Hughes', 2013; Durmaz & Mutlu, 2017; Fischer et al., 2009; Herrenkohl & Tasker, 2011; Mangrubang, 2004; Passmore, Stewart, & Cartier, 2010). This study has added to the prior literature for others to replicate the research study, explore ways to increase science achievement, and improve teacher effectiveness.

The results of the research study suggest that various entities can benefit from the instructional design model. The participants in this study will be able to apply these findings to assist with increasing science achievement in their school and develop a plan to increase science in grades K through four. The school and district administration can use this study to ensure science teachers are prepared to teach science through connecting science to the real world, managing lessons using inquiry and centers, implementing hands-on experiments, connecting science and literacy, and incorporating technology in the lesson plans.

Closing Comments

The researcher focused on Grade 5 students at a local school where there was a pattern of low on science achievement scores. The purpose of the study was to determine whether the instructional design model would improve science achievement at the local school. Research and publications have documented the concern that low science achievement could result in a lack of students in postsecondary education in science related fields (Blank, 2013; Martin et al., 2011; Martin et al., 2016; Passmore, Stewart, & Cartier, 2010; Smith & Stroll, 2010; Taylor et al., 2017).

Science test scores. The findings in the research study showed that the use of the instructional design model did have an impact on Grade 5 students' science post-test results; these results aligned with Durmaz and Mutlu (2017) and Cotabish et al. (2013) findings that an instructional intervention in science improves science test scores. Durmaz and Mutlu (2017) reported a statistically significant increase in science achievement scores compared to students that did not receive the intervention. Cotabish et al. (2013) reported an increase in students' science knowledge, processing skills, and science concepts relative to students that did not receive the intervention. Based on the findings of these studies, when science instruction is planned with different strategies to develop students' knowledge, understanding, and application of the science concepts, students' science scores will increase.

Classroom observations. The instructional design model was found to influence a student's ability to understand and learn the science concepts being taught as observed and measured using structured classroom observations. The classroom observations were broken down into seven element descriptions: "identifying critical content, elaborating on new information, recording and representing knowledge, examining similarities and differences, examining errors in reasoning, revising knowledge, and engaging students in cognitively complex tasks involving hypothesis generation and testing" (Marzano, 2013, p. 4) to determine effective teaching that would increase student achievement in science.

The first section of the observation form was identifying critical content. The teachers informed students of key points critical for learning the lesson at the beginning of class 100% of the time. Therrien, Benson, Hughes, and Morris (2017) asserted that teachers identifying the critical content of the lesson were essential for student success.

The second section on the observation form was elaborating on new information. The teachers facilitated organized collaboration among students while they elaborated on new information in the science classrooms 100% of the time. Allen, Smith, Thoman, and Walters (2018), Monaghan (2015), and Walter (2018) confirmed that collaboration in science class increase students' motivation to engage in science concepts. The third section on the observation form was recording and representing knowledge. The teachers gave students with strategies to record and represent knowledge 80% of the time and monitored the students as they recorded the information 90% of the time. Hudson (2013) concluded that strategies such as recording and representing knowledge have an effect on student achievement in elementary science.

The fourth section on the observation form was examining similarities and differences. The teachers asked students to explain their thinking 80% of the time when examining similarities and differences and provided students with intentional learning experiences 90% of the time. Critical thinking skills were utilized by the students to determine similarities and differences among concepts in the lessons. The fifth section on the observation form was examining errors in reasoning. The teachers allowed students opportunities to collaborate 90% of the time, provided intentional learning experiences for the students 100% of the time, and monitored the students using evidence from their science text 80% of the time regarding their examining errors in reasoning. Students were encouraged to collaborate with their groups about their correct and incorrect answers, pull evidence from the text to support their answers, and the teachers actively monitored the students.

The sixth section in the observation form was revising knowledge. The teachers provided intentional learning experiences for the students to revise knowledge 90% of the time. They determined where in the lesson, the students would revise their work based on what they learned in the lesson. The seventh section of the observation tool was engaging students in cognitively complex tasks involving hypothesis generating and testing. The teachers provided students with opportunities to have science rich discussions 80% of the time, allowing the students a chance for student-to-student discourse (Craddock, 2017) and engaging students in cognitively complex tasks involving hypothesis generating and testing. Miller (2014) confirmed that “effective utilization of the inquiry-based learning approach demands inclusion of learners in a self-directed learning environment, the ability to think critically, and an understanding of how to reflect and reason scientifically” (p. 3), thereby providing the students with “a more motivating and learner-centered environment” (p. 86).

Interviews. The teacher participants felt that the instructional design model boosted student achievement compared to their previous teaching approaches. The participants expressed their perceptions during the interviews regarding the teaching approach. The participants’ responses aligned with Sakiz’s (2015) argument that when teachers are prepared and understand science concepts, “students focus more on learning, development, improvement, and understanding; they use more effective learning strategies and prefer more challenging tasks, demonstrate less disruptive behaviours” (p. 116).The participants of the research study communicated that using the instructional design model translated into improved post-test results such as 52% increased to 76, 4% increased to a 68%, and 20% increased to 68%. The researcher correlated the participants' perception and post-test scores with a need for the instructional design model in Grade 5 science classes.

Implications of Findings

This research study reinforces a need for a change in policy regarding giving teachers sufficient time for planning science lessons and providing teachers with feedback on their lessons. Marshall (2018) expressed, "little is known how science policies are being adopted in elementary schools in the era of both the Common Core State Standards and the Next Generations Science Standards" (p. 92). In an action research study involving kindergarten through Grade 6, it was found that when elementary teachers deconstructed the concepts and discussed possible misconceptions, the teachers were able to plan, teach, and facilitate science content and laboratory experiments effectively (Cullen, Akerson, & Hanson, 2010).

Teachers should be given opportunities to develop their understanding of specific science concepts, observe other teachers facilitating these concepts in classrooms, and partner with professionals in the fields related to the grade level content. Teachers are struggling to make the connections or articulate the science content connections because they lack science understanding and are not able to plan efficiently for the lesson (Buaraphan, 2011; Herrenkohl & Tasker, 2011; Mangrubang, 2004). Vail (2011) concluded that professional development experiences were powerful because they allowed them to meet other professionals and grow their network of support and resources" (p. 150). Baker et al. (2009), Cullen et al. (2010), and Velthuis et al. (2013) agreed that professional development would assist with teachers' development in science content and instruction as educators. Based on effective professional development, teachers become facilitators of learning in the classroom (Bulunuz & Jarrett, 2010) because they understand the science concepts (Steele, Brew, Rees, & Ibrahim-khan, 2013).

Science in elementary school should be valued within our educational system; educators should ensure a clear scheduled time for science instruction and organize science systematically across all elementary school years. As of 2019, in Florida, science is only required 120 minutes per week, and it can be taught through reading. The Nation operates under ESSA (Johnson, 2016; Sharp, 2016) regarding high-quality education; however, most of the accountability is based on NCLB (Johnson, 2016; Park, 2016) and the value of high-stakes testing (Marshall, 2018). Since Grades 3 through 5 mathematics and reading have more value in Florida's high-stake testing, science is only emphasized in the Grade 5 class because it is the only year assessed by the state (Johnson, 2016; Sharp 2016; United States Department of Education, 2008).

Limitations

Limitations are "constraints that are largely beyond your control but could affect the study outcome" (Simon & Goes, 2013, p. 2). The following limitations were identified during the course of the implementation of this study.

The first limitation was the sample size. The sample size in this study was very small, thus limiting the generalizability of the research findings. The initial proposal suggested that the sample size would be 93 students; however, the researcher was only able to obtain approval for 60 students. This study only involved five teachers in one school and the data from the pre- and post-tests of the 2017-2018 and 2018-2019 school years. Therefore, the study pertained to only the science teachers and assigned students at this school and may not be applicable or pertinent to teachers, students, or schools in other settings.

The second limitation was the teachers' science classroom experience. In this study, the five teachers had a variety of experiences teaching science, which may have resulted in their inability to implement the instructional design model with fidelity. The teachers developed lesson plans together in common planning meetings; however, each teacher's style of teaching is different based on their experiences and science background. Nowicki, Sullivan-Watts, Shim, Young, and Pockalny (2013) concluded that even with professional development and provided curricular materials, elementary science teachers lack experience teaching science. Therefore, the teachers with less science experience lack confidence regarding teaching science and personal teaching experiences (Knaggs & Sondergeld, 2015).

The third limitation was the participants' socio-economic backgrounds. The student participants attend a Title 1 school; they may not have the resources such as science books, technology, and support out of school and there may be some social and economic factors that negatively impact the study that is beyond the researcher's control. Kenar, Köse, and Demir (2016) stated that "an increase in family income status ends up with an increase in their attitudes towards science" (p. 155). There are examples of studies that find positive associations between science achievement and prior knowledge of science concepts (Andersen, Humlu, & Nandrup, 2016; Bousselot 2018; Fisher, Ross, & Grant, 2010; Nyberg, 2014).

Recommendations for Future Research

This section contains recommendations for future considerations based upon the professional educational experience of the researcher combined with information acquired during the implementation of this research study. Based on the findings in the study, the researcher offers the following two recommendations. First, based on the review of the literature and the post-test data, educational reformers, professional developers, teacher preparedness programs, and policymakers should allocate additional time for science instruction planning and weekly science instruction in elementary schools. Second, based on the data collected from the classroom observations and teacher interviews, educational stakeholders should increase opportunities for teacher planning and collaboration; this will allow teachers to develop lesson plans that include introducing the concept, hands-on activities, reading text to support the content, time for students to collaborate, and allowing students to revise their thinking based on the lesson.

References

Ababneh, E., Al-Tweissi, A., & Abulibdeh, K. (2016). TIMSS and PISA impact--the case of Jordan. *Research Papers in Education, 31*(5), 542-555. doi:10.1080/02671522.2016.1225350

Ahn, R., Asanuma, S., & Mori, H. (2016). Japan's teachers earn tenure on day one. *Phi Delta Kappan*, 97(6), 27-31. doi:10.1177/0031721716636868

Allen, J., Smith, J. L., Thoman, D. B., & Walters, R. W. (2018). Fluctuating team science: Perceiving science as collaborative improves science motivation. *Motivation Science, 4*(4), 347-361. doi:10.1037/mot0000099

Anderhag, P., Hamza, K. M., & Wickman, P. (2015). What can a teacher do to support students' interest in science? A study of the constitution of taste in a science classroom. *Research in Science Education, 45*(5), 749-784. Retrieved from doi:10.1007/s11165-014-9448-4

Andersen, S. C., Humlum, M. K., & Nandrup, A. B. (2016). Increasing instruction time in school does increase learning. *Proceedings of the National Academy of Sciences of the United States of America*, *113*(27), 7481-7484. doi:10.1073/pnas.1516686113

Aslan, D., Tas, I., & Ogul, I. G. (2016). Pre- and in-service preschool teachers' science teaching efficacy beliefs. *Educational Research and Reviews, 11*(14), 1344-1350. http://doi.org/10.5897/ERR2016.2794

Baker, D, Lewis, E. B., Purzer, S., Watts, N. B., Perkins, G., Uysal, S., … Lang, M. (2009). The communication in science inquiry project (CISIP): A project to enhance scientific literacy through the creation of science classroom discourse communities. *International Journal of Environmental & Science Education, 4*(3), 259-274.

Banilower, E. R., Fulp, S. L., & Warren, C. L. (2010). *Science: It's elementary. Year four evaluation report*. Horizon Research, 326 Cloister Court, Chapel Hill, NC 27514. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/870288618?accountid=6579

Barney, L. S., & Maughan, B. D. (2015). Getting out of the way: Learning, risk, and choice. *Complicity: An International Journal of Complexity and Education, 12*(2), 49-80. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1773220361?accountid=6579

Belk, E. J., Seed, A. H., & Abdi, W. (2005). Content reading strategies. *Science Scope, 28*(6), 44-45. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/225998261?accountid=6579

Berlin, D. F., & Hillen, J. A. (1994). Making connections in math and science: Identifying student outcomes. *School Science and Mathematics, 94*(6), 283. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/195228509?accountid=6579

Bishop, J. P., & Jackson, J. H. (2015). Fifty years later: A chance to get ESEA back on track. *Education Policy Analysis Archives, 23*(24). http://dx.doi.org/10.14507/epaa.v23.2025

Blank, R. K. (2012). Science instructional time is declining in elementary schools: What are the implications for student achievement and closing the gap? *Science Education, 97*(6), 830-847. doi:10.1002/sce.21078

Bonus, M., & Riordan, L. (1998) *Increasing student on-task behavior through the use of specific seating arrangements.* Retrieved from https://eric-ed-gov.ezproxylocal.library.nova.edu/?id=ED422129

Bousselot, T. E. (2018). Shifting the focus to science in the early elementary years: An examination of science achievement growth in grades K-2 using a nationally representative dataset. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/2090125721?accountid=6579

Boyd, D. J., Grossman, P. L., Lankford, H., Loeb, S., & Wyckoff, J. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis, 31*(4), 416-440. doi:10.3102/0162373709353129

Branscome, E. (2012). The impact of education reform on music education: Paradigm shifts in music education curriculum, advocacy, and philosophy from “Sputnik” to race to the top. *Arts Education Policy Review, 113*(3), 112-118. doi:10.1080/10632913.2012.687341

Buaraphan, K. (2011). The impact of the standard-based science teacher preparation program on pre-service science teachers’ attitudes toward science teaching. *Journal of Turkish Science Education, 8*(1), 61-78. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1659748443?accountid=6579

Bulunuz, N., & Jarrett, O. (2010). The effects of hands-on learning stations on building American elementary teachers' understanding about earth and space science concepts. *Eurasia Journal of Mathematics & Science Technology Education, 6*(2), 85-99.

Campbell, M. D. (2013). *Using the learning together strategy to affect student achievement in physical science.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1312344568?accountid=6579

Carnevale, A. P., Smith, N., & Strohl, J. (2010). *Help wanted: Projections of jobs and education requirements through 2018*. Retrieved from ERIC Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/964173249?accountid=6579

Cervetti, G., & Barber, J. (2009). Bringing back books. *Science and Children, 47*(3), 36-39. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/61805253?accountid=6579

Chabe, A. (1971). Soviet educational policies; the development, administration, and content. Retrieved from http://www.ascd.org/ASCD/pdf/journals/ed_lead/el_197102_chabe.pdf

Cheidvasser, S., & Benítez-Silva, H. (2007). The educated Russian's curse: Returns to education in the Russian Federation during the 1900s. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/j.1467-9914.2007.00365.x

China's education. (2016). Retrieved from http://www.cscse.edu.cn/publish/portal0/tab132/info8897.htm

Choi, S., & Ramsey, J. (2009). Constructing elementary teachers' beliefs, attitudes, and practical knowledge through an inquiry-based elementary science course. *School Science and Mathematics, 109*(6), 313-324. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/815958826?accountid=6579

Chowdbury, M.F. (2015). Coding, sorting and sifting qualitative data analysis: Debates and discussions. Quality and Quantity, 49(3), 1135-1143. doi:10.1007/s11135-014-0039-2

Concepts of Leadership. (2010). Concepts of Leadership. Retrieved from http://www.nwlink.com/~donclark/leader/leadcon.html

Contino, J. (2013). A case study of the alignment between curriculum and assessment in the New York State Earth Science standards-based system. *Journal of Science Education and Technology*, *22*(1), 62-72. Retrieved from https://search-proquest-com.ezproxylocal.library.nova.edu/docview/1347460231?accountid=6579

Cotabish, A., Dailey, D., Robinson, A., & Hughes, G. (2013). The effects of a STEM intervention on elementary students’ science knowledge and skills. *School Science and Mathematics, 113*(5), 215-226. doi:10.1111/ssm.12023

CPALMS. (2012). *Grade 4 Science Course Description*. Retrieved from http://www.cpalms.org/Courses/CourseDescriptionSearch.aspx

Craddock, J. L. (2017). The perceptions of elementary school teachers regarding their efforts to help students utilize student-to-student discourse in science. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1968426168?accountid=6579

Creswell, J., & Clark, V. (2018). *Designing and conducting mixed methods research.* Thousand Oaks, CA: Sage Publications.

Creswell, J. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J. (2014). *Research design: Qualitative, Quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publications.

Creswell, J. (2015). *A concise introduction to mixed methods research*. Thousand Oaks, CA: Sage.

Cullen, T., Akerson, V., & Hanson, D. (2010). Using action research to engage K-6 teachers in nature of science inquiry as professional development. *Journal Science Teacher Education, 21(8)*, 971-992. doi:10.1007/s10972-010-9218-8

Dalton, B., & Proctor, C. P. (2007). Reading as thinking: Integrating strategy instruction in a universally designed digital literacy environment. In D. S. McNamara (Ed.), *Reading comprehension strategies: Theories, interventions, and technologies* (pp. 423-442). Mahweh, NJ: Lawrence Erlbaum Publishers.

Deng, Z., & Gopinathan, S. (2016). PISA and high-performing education systems: explaining Singapore's education success. *Comparative Education, 52*(4), 449-472. doi:10.1080/03050068.2016.1219535

Denham, T. (2002). Comparison of two curriculum/instructional design models: Ralph W. Tyler and Siena College accounting class, ACCT205. Retrieved from http://www.eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED471734&ERICExtSearch_SearchType_0=no&accno=ED471734

Dixon, P., & Wilke, R. (2007). The influence of a teacher research experience on elementary teachers' thinking and instruction. *Journal of Elementary Science Education*, *19*(1), 25-43.

Durmaz, H., & Mutlu, S. (2017). The effect of an instructional intervention on elementary students' science process skills. *Journal of Educational Research, 110*(4), 433-445. doi:10.1080/00220671.2015.1118003

Elementary and secondary education act of 1965, as amended by the every student succeeds act--accountability and state plans. (2016). Washington: Federal Information & News Dispatch, Inc. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1844700703?accountid=6579

Fisher, D., Grant, M., & Frey, N. (2009). Science literacy is strategies. *The Clearing House*, 184-186. Retrieved from http://www.fisherandfrey.com/wp-content/uploads/2010/01/ch-science_lit.pdf

Fisher, D., Ross, D., & Grant, M. (2010). Building background knowledge. *The Science Teacher, 77*(1), 23-26. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/214617640?accountid=6579

Florida Department of Education. (2005). *Office of Assessment Division of Accountability, Research and Measurement.* Retrieved from http://www.fldoe.org/arm/

Florida Department of Education. (2014). *FCAT 2.0 Science test item specification version 2 grade 5*. Retrieved from http://www.fldoe.org/core/ fileparse.php/5682/urlt/0077913-fl09g5sci.pdf

Florida Department of Education. (2009). *Florida Standards*. Retrieved from http://www.fldoe.org/core/fileparse.php/7535/urlt/0102886-sciencespecs2009.pdf

Florida Department of Education. (2013a). *2013 FCAT 2.0 results in Excel format.* Retrieved from http://www.fldoe.org/arm/

Florida Department of Education. (2013b). *2013 Science Content Focus Grade 5.* Retrieved from http://fcat.fldoe.org/fcat2/pdf/2013ScienceContentFocus.pdf

Florida Department of Education. (2016). *Fact sheet*. Retrieved from http://www.fldoe.org/core/fileparse.php/5663/urlt/1516NGSSSScienceReadingRFS.pdf

Florida Department of Education. (2012). *2012 Science Content Focus Grade 5.* Retrieved from http://fcat.fldoe.org/fcat2/pdf/ScienceContentFocus2012.pdf

Florida Department of Education Office of Assessment. (2012). *Cognitive complexity classification of the statewide assessment test items*. Retrieved from http://www.fldoe.org/core/fileparse.php/3/urlt/cognitivecomplexity.pdf

Florida Department of Education Office of Assessment. (2013). *FCAT 2.0 and Florida EOC assessments achievement levels*. Retrieved from http://www.fldoe.org/core/fileparse.php/5662/urlt/0095809-achlevel.pdf

Florida Department of Education Office of Assessment. (2016). *Florida standards assessment statewide science assessment*. Retrieved from http://www.fldoe.org/accountability/assessments/k-12-student-assessment/results/2016.stml

Florida Department of Education Office of Assessment. (2017). *Florida standards assessment statewide science assessment*. Retrieved from http://www.fldoe.org/accountability/assessments/k-12-student-assessment/results/2017.stml

Florida Department of Education Office of School Improvement. (2018). *Regional support to school districts.* Retrieved from http://www.fldoe.org/schools/k-12-public-schools/school-improvement/reg-support.stml

Florida Department of State. (2013). *Differentiated accountability state system of school improvement.* Retrieved from https://www.flrules.org/gateway/ruleNo.asp?id=6A-1.099811

Fulmer, G. (2011). Estimating critical values for strength of alignment among curriculum, assessments and instruction. *Journal of Educational and Behavioral Statistics*, 36, 381-402.

Gardner, D. (1983). A nation at risk: The imperative for educational reform. An open letter to the American people. A report to the nation and the secretary of education. Retrieved from https://files.eric.ed.gov/fulltext/ED226006.pdf

Geier, R., Blumenfeld, P. C., Marx, R., Krajcik, J., Fishman, B., Soloway, E., & Clay-Chambers, J. (2008). Standardized test outcomes for students engaged in inquiry-based science curricula in the context of urban reform. *Journal of Research in Science Teaching*, *45(*8) 922-939.

Giles, J., Park, A., & Wang, M. (2015). The great proletarian cultural revolution, disruptions to education, and the returns to schooling in urban China. Retrieved from https://poseidon01.ssrn.com/delivery.php?ID=026097084021001072086005065109120093042064029044054013126030124068022075002065105077021017000033037038043080089020067066116091121053047082012084124124107070066115125029040044110094102010065124000104113066109127119097090027065121097108074027120120001027&EXT=pdf

Gordon, M. (2016). Why should scholars keep coming back to John Dewey? *Educational Philosophy and Theory, 48*(10), 1077-1091. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1871575924?accountid=6579

Hamilton, L. (2003). Assessment as a policy tool. *Review of Research in Education,* 27, 25-68.

Hardin, C. (2009). *Effectiveness and accountability of the inquiry-based methodology in middle school science.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/61863131?accountid=6579

Herrenkohl, L. R., & Tasker, T. (2011). Pedagogical practices to support classroom cultures of scientific inquiry. Cognition and Instruction, 29(1), 1-44.

Herrick, V., & Tyler, R. (1950). The organization of learning experiences. *Towards Improved Curriculum Theory, 70*, 59-67.

Hill, J. (2011) Time in school: How does the U.S. compare? Retrieved from http://www.centerforpubliceducation.org/research/time-school-how-does-us-compare

Hollingworth, L. (2007). Five ways to prepare for standardized tests without sacrificing best practice. *The Reading Teacher*, *61*(4), 339-342. https://doi.org/10.1598/RT.61.4.7

House, D. (2012). Science achievement of elementary-school students in the United States and Japan in TIMSS 2007: An assessment of the effects of technology engagement and classroom lesson activities. *International Journal of Instructional Media, 39*(3), 263-274.

Hudson, D. (2013). *The effect of thinking maps on fifth grade science achievement.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1312337864?accountid=6579

Iatarola, P. & Gao, N. (2015). High school accountability: Early evidence from Florida's Broward County Public Schools. Retrieved from https://files-eric-ed-gov.ezproxylocal.library.nova.edu/fulltext/ED561252.pdf

Im, S., Yoon, H., & Cha, J. (2016). Pre-service science teacher education system in South Korea: Prospects and challenges. *Eurasia Journal of Mathematics, Science and Technology Education, 12*(7), 1863-1880. doi:10.12973/eurasia.2016.1533a

Islam, R., & Ismail, A. (2008) Employee motivation: A Malaysian perspective. *International Journal of Commerce and Management, 18*(4). *Retrieved from* http://go.galegroup.com.ezproxylocal.library.nova.edu/ps/i.do?id=GALE%7CA191855927&v=2.1&u=novaseu_main&it=r&p=GPS&sw=w

Istiningsih. (2016). Charcter education of the most developed countries in ASEAN. *Journal of Education and e-Learning Research, 3*(1), 32-37. Retrieved from https://files-eric-ed-gov.ezproxylocal.library.nova.edu/fulltext/EJ1148551.pdf

Jantarakantee, E., Roadrangka, V., & Clarke, A. (2012). Pre-service science teachers' understandings of classroom research and the problems in conducting classroom research projects. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1011396657?accountid=6579

Jenset, I. S., Klette, K., & Hammerness, K. (2018). Grounding teacher education in practice around the world: An examination of teacher education coursework in teacher education programs in Finland, Norway, and the United States. *Journal of Teacher Education, 69*(2), 184-197. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/2024000679?accountid=6579

Johnson, M. (2016). *The every student succeeds act: Opportunities and responsibilities.* Hunt Institute. 1000 Park Forty Plaza Suite 280, Durham, NC 27713. Retrieved from ERIC Retrieved from https://eric-ed-gov.ezproxylocal.library.nova.edu/?id=ED569954

Kang, E., Bianchini, J., & Kelly, G. (2013). Crossing the border from science student to science teacher: Preservice teachers' views and experiences learning to teach inquiry. *Journal of Science Teacher Education, 24*(3), 427-447. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1361832855?accountid=6579

Kang, H. T., & Noh, S. G. (2017). The effect on elementary science education based on student's pre-inquiry. *Universal Journal of Educational Research*, *5*(9), 1510-1518. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1969018612?accountid=6579

Kazempour, M. (2014). I can't teach science! A case study of an elementary pre-service teacher's intersection of science experiences, beliefs, attitude, and self-efficacy. *International Journal of Environmental and Science Education*, *9*(1), 77-96. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1606048541?accountid=6579

Kenar, I., Köse, M., & Demir, H. I. (2016). Determination of motivation of 5th grade students living in rural and urban environments towards science learning and their attitudes towards science-technology course. *Journal of Education and Training Studies, 4*(7), 155-167. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1826526724?accountid=6579

Kensinger, S. H. (2012). *Impact of instructional approaches to teaching elementary science on student achievement.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1022189196?accountid=6579

Kern, D., Andre, W., Schilke, R., Barton, J., & McGuire, M. C. (2003). Less is more: Preparing students for state writing assessments. *The Reading Teacher*, *56*(8), 816-826.

Kimberlin, C. & Winetrstein, A. (2008). Validity and reliability of measurement instruments used in research. *American Journal of Health System Pharmacy, 65*(23), 2276-2284. Retrieved from http://eds.a.ebscohost.com.ezproxylocal.library.nova.edu/eds/results?vid=2&sid=a4bb5b08-affb-42c9-b1e6-11a8c5af7769%40sdc-v-sessmgr05&bquery=doi%3a+10.2146%2fajhp070364&bdata=JmNsaTA9RlQxJmNsdjA9WSZ0eXBlPTAmc2l0ZT1lZHMtbGl2ZQ%3d%3d

Knaggs, C. M., & Sondergeld, T. A. (2015). Science as a learner and as a teacher: Measuring science self-efficacy of elementary preservice teachers. *School Science and Mathematics, 115*(3), 117-128. doi:10.1111/ssm.12110

Kose, S., Sahin, A., Ergun, A., & Gezer, K. (2010). The effects of cooperative learning experience on eighth grade students' achievement and attitude toward science. *Education, 131*(1), 169-180. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/860367848?accountid=6579

KPMG. (2010). Infrastructure, government, & healthcare education in China. Retrieved from https://www.kpmg.de/docs/Education-in-China-201011.pdf

Krechetnikov, G. K., & Pestereva, M. N. (2017). A comparative analysis of the education systems in Korea and Japan from the perspective of internationalization. *European Journal of Contemporary Education*, *6*(1), 77-88. Retrieved from

http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1913345774?accountid=6579

Lee, D., Huh, Y., & Reigeluth, C. M. (2015). Collaboration, intragroup conflict, and social skills in project-based learning. *Instructional Science, 43*(5), 561-590. doi:10.1007/s11251-015-9348-7

Leonard, J., Boakes, N., & Moore, C. M. (2009). Conducting science inquiry in primary classrooms: Case studies of two preservice teachers' inquiry-based practices. *Journal of Elementary Science Education*, *21*(1), 27-50. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/61862600?accountid=6579

Lotter, C., Harwood, W. S., & Bonner, J. J. (2007). The influence of core teaching conceptions on teachers' use of inquiry teaching practices. *Journal of Research in Science Teaching, 44*(9), 1318-1347. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/62059626?accountid=6579

Lundstrom, M. (2005). Link science & literacy and watch test scores skyrocket. *Instructor*, *114*(6), 25-26. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/61911431?accountid=6579

Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Teaching and Learning in Higher Education, 8(3),* 3351-3359. Retrieved from http://ojs.aishe.org/index.php/aishe-j/article/viewFile/335/553

Mangrubang, F. R. (2004). Preparing elementary education majors to teach science using an inquiry-based approach: The full option science system. *American Annals of the Deaf, 149*(3), 290-303. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/214468614?accountid=6579

Martin, M., Mullis, I., Foy, P., & Stanco, G. (2011). *TIMSS 2011 International results in science.* Boston, MA: TIMSS & PIRLS International Study Center. Retrieved from https://timssandpirls.bc.edu/timss2011/international-results-science.html

Martin, M., Mullis, I., Foy, P., & Hooper, M. (2016). *TIMSS 2015 International results in science.* Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/

Marshall, S. L. (2018). *Elementary principal networks: Sensemaking of science education policy post- NCLB.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/2090896845?accountid=6579

Marzano, R. J., Boogren, T., Heflebower, T., Kanold-McIntyre, J., & Pickering, D. (2012). *Becoming a reflective teacher*. Bloomington, IN: Marzano Research Laboratory.

Marzano, R., Carbaugh, B., Rutherford, A., & Toth, M. (2013). Marzano center teacher observation protocol for the 2014 Marzano teacher evaluation model. Retrieved from http://www.marzanocenter.com/Teacher-Evaluation-2014-Model.pdf

Marzano, R. & Toth, M. (2014). Teaching for rigor: A call for a critical instructional shift. Retrieved from http://rcbhighschool.com/wp-content/uploads/MC05-01-Teaching-for-Rigor-Paper-05-20-14-Digital-1.pdf

Mehalik, M., Doppelt, Y., & Schuun, C. (2008). Middle-school science through design-based learning verses scripted inquiry: Better overall science concept learning and equity gap reduction. *Journal of Engineering Education*, *71*-85

Metz, S. (2014). Math-science connections. *The Science Teacher*, *81*(5), 6. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1537947624?accountid=6579

Miles, M. B., Huberman, A. M., & Saldaäna, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd edition.). Thousand Oaks, CA: SAGE Publications, Inc.

Miller, D. K. G. (2014). *The effect of inquiry-based, hands-on labs on achievement in middle school science.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1564233332?accountid=6579

Ministry of Education. (2017). Finnish education in a nutshell. Retrieved from https://www.oph.fi/download/146428_Finnish_Education_in_a_Nutshell.pdf

Ministry of Education Singapore. (2018). Education. Retrieved from https://www.moe.gov.sg/education/school-terms-and-holidays#pri-sec-sch-term-2018

Ministry of Education, Science and Culture and the Science and Technology Agency. (2018). Education. Retrieved from http://www.mext.go.jp/en/policy/education/overview/index.htm

Moher, T., Wiley, J., Jaeger. A., Silva, B. L., & Novellis, F. (2010). Spatial and temporal embedding for science inquiry: An empirical student of student learning. *International Society of the Learning Sciences*, *1*, 826-833

Monaghan, J. R. (2015). *Scaffolds in a middle school science classroom: Problem-based learning and field trip experience.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1706292945?accountid=6579

Moon, B. (2016). *Do universities have a role in the education and training of teachers? An international analysis of policy and practice*. Cambridge, UK: Cambridge University Press.

Morrison, G., Ross, S., Kalman, H., & Kemp, J. (2011). *Designing effective instruction* (6th ed). Hoboken, NJ: John Wiley & Sons.

Moustakas, C. (1994). *Phenomenological research methods.* Thousand Oaks, CA: Sage.

Murawska, J. M., & Walker, D. A. (2017). Visual tools for eliciting connections and cohesiveness in mixed methods research. *Mid-Western Educational Researcher, 29*(3), 274-290. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/2009560531?accountid=6579

Nakayasu, C. (2016). School curriculum in Japan. *The Curriculum Journal, 27*(1), 134-150. doi:10.1080/09585176.2016.1144518

Na, J., & Song, J. (2014). Why everyday experience? Interpreting primary students' science discourse from the perspective of John Dewey. *Science & Education, 23*(5), 1031-1049. Retrieved from

http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1651863132?accountid=6579

National Center for Education Statistics. (2016). Highlights from TIMSS and TIMSS advanced 2015. Retrieved from https://nces.ed.gov/pubs2017/2017002.pdf

Newton, J. A., & Kasten, S. E. (2013). Two models for evaluating alignment of state standards and assessments: Competing or complementary perspectives? *Journal for Research in Mathematics Education, 44*(3), 550-580. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1651833549?accountid=6579

Niemi, H., Toom, A., & Kallioniemi, A. (2016). *Miracle of education: The principles and practices of teaching and learning in Finnish schools* (2nd ed.). The Netherlands: Sense Publishers.

Nikolaev, D., & Chugunov, D. (2012). *The education system in the Russian Federation: Education brief 2012*. Washington D.C: The World Bank.

Northouse, P. G. (2012). *Introduction to leadership* (2nd ed.). Thousand Oaks, CA: Sage Publishing.

Nowakowski, J. R. (1983). On educational evaluation: A conversation with Ralph Tyler. *Educational Leadership, 40*(8), 24-29. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/63529372?accountid=6579

Nowakowski, J. R. (2011). An interview with Ralph Tyler. *Journal of MultiDisciplinary Evaluation, 7*(15), 202-226. Retrieved from

http://search.proquest.com.ezproxylocal.library.nova.edu/docview/860366227?accountid=6579

Nowicki, B. L., Sullivan-Watts, B., Shim, M. K., Young, B., & Pockalny, R. (2013). Factors influencing science content accuracy in elementary inquiry science lessons. *Research in Science Education, 43*(3), 1135-1154. doi:10.1007/s11165-012-9303-4

Nuangchalerm, P. (2014). Inquiry-based learning in china: Lesson learned for school science practices. *Asian Social Science, 10*(13), 64-70. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1651829957?accountid=6579

Nyberg, L. (2014). Methods and strategies: Seeding science in elementary schools.*Science and Children, 51*(7), 84-88. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1651847059?accountid=6579

Ocasio, T. & Marzano, R. (2015). Examining reasoning. Retrieved from https://www.learningsciences.com/media/catalog/product/e/r/er_lookinside.pdf

OECD. (2016). Education in China: A snapshot. Retrieved from https://www.oecd.org/china/Education-in-China-a-snapshot.pdf

Oliverira, A. (2009). Engaging students in guided science inquiry discussions: Elementary teachers' oral strategies. *Journal Science Teacher Education*, *21*, 747-765.

Panasan, M., & Nuangchalern, P. (2010). Learning outcomes of project-based and inquiry-based learning activities. *Journal of Social Sciences*, *6(*2), 252-255. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/742872328?accountid=6579

Park, J. (2013). *Explaining achievement disparities between the United States and South Korea* (Order No. 3589129). Available from Education Database; ProQuest Dissertations & Theses Global: Social Sciences. (1438194153). Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1438194153?accountid=6579

Park, J., Choi, J., & Lee, Y. (2013). Analysis of instruction models in SMART education. *International Association for the Development of the Information Society*. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1871586361?accountid=6579

Park, M., & Sung, Y. (2013). Teachers' perceptions of the recent curriculum reforms and their implementation: What can we learn from the case of Korean elementary teachers? *Asia Pacific Journal of Education*, *33*(1), 15-33. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1322244880?accountid=6579

Passmore, C., Stewart, J., & Cartier, J. (2010). Model-based inquiry and school science: Creating connections. *School Science and Mathematics, 109*(7), 394-402. https://doi.org/10.1111/j.1949-8594.2009.tb17870

Patton, J. E., Snell, J., Knight, W. J., & Gerken, K. (2001). *A survey study of elementary classroom seating designs.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/62349207?accountid=6579

Pietkiewicz, I. & Smith, J. (2014). A practical guide to using interpretative phenomenological analysis in qualitative research psychology. Retrieved from https://www.researchgate.net/publication/263767248_A_practical_guide_to_using_Interpretative_Phenomenological_Analysis_in_qualitative_research_psychology

Romain, M. A., Millner, K. A., Moss, V. E., & Held, M. (2007). The effectiveness of classroom-based instructional assessments for progress monitoring purposes in Texas reading first schools. *Reading and Writing*, *20*(6), 619-641. Retrieved from doi:10.1007/s11145-007-9057-y

Rudolph, J. L. (2014). Dewey's "science as method" a century later: Reviving science education for civic ends. *American Educational Research Journal, 51*(6), 1056-1083. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1651837599?accountid=6579

Sahlberg, P. (2011). *Finnish lessons: What can the world learn from educational change in Finland?* New York City, NY: Teachers College Press.

Sakiz, G. (2015). Perceived teacher factors in relation to students' achievement-related outcomes in science classrooms in elementary school. *European Journal of Science and Mathematics Education*, *3*(2), 115-129. Retrieved from

http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1826539232?accountid=6579

Saldana, J. (2016). *The coding manual for qualitative researchers.* Thousand Oaks, CA: Sage Publications.

Sanders, B. R. (2010). *School leaders and the challenge of the elementary and secondary education act, 1960-1968.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/763491343?accountid=6579

Schleicher, A., & Stewart, V. (2008). Learning from world-class schools. *Educational Leadership*, *66*(2), 44-51. Retrieved from http://web.b.ebscohost.com.ezproxylocal.library.nova.edu/ehost/pdfviewer/pdfviewer?vid=1&sid=39fa8e6b-4e84-4fce-b08b-0515d5f9226c%40sessionmgr104

Schmidt, R., & Marzano, R. (2015a). Recording and representing knowledge. Retrieved from https://www.learningsciences.com/media/catalog/product//r/r/rrk_lookinside.pdf

Schmidt, R., & Marzano, R. (2015b). Revising knowledge. Retrieved from https://www.learningsciences.com/media/catalog/product//r/k/rk_lookinside.pdf

Schwarz, C. (2009). Developing preservice elementary teachers' knowledge and practices through modeling-centered scientific inquiry. *Science Education, 93*(4), 720-744. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/61863702?accountid=6579

Seidman, I. (2013). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*. New York City, NY: Teachers College Press.

Senn, D. & Marzano, R. (2015). Engaging in cognitively complex tasks. Retrieved from https://www.learningsciences.com/media/catalog/product//e/i/eicct_lookinside-min.pdf

Sharp, L. A. (2016). ESEA reauthorization: An overview of the every student succeeds act. *Texas Journal of Literacy Education, 4*(1), 9-13. Retrieved from https://eric-ed-gov.ezproxylocal.library.nova.edu/?id=EJ1110854

Simon, M., & Goes, J. (2013) Assumptions, limitations, delimitations, and scope of the study. Retrieved from http://www.dissertationrecipes.com/wp-content/uploads/2011/04/Assumptions-Limitations-Delimitations-and-Scope-of-the-Study.pdf

Smith, G. (2011). How to attract, retain and motivate today's workforce. *Diversity Journal.* Retrieved from http://www.diversityjournal.com/5026-how-to-attract-retain-and-motivate-todays-workforce/

Standerfer, L. (2006). Before NCLB: The history of ESEA. *Principal Leadership, 6*(8), 26-27. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/233341760?accountid=6579

Steele, A., Brew, C., Rees, C., & Ibrahim-khan, S. (2013). Our practice, their readiness: Teacher educators collaborate to explore and improve preservice teacher readiness for science and math instruction. *Journal of Science Teacher Education, 24*(1), 111-131. https://doi.org/10.1007/s10972-012-9311-2

Steeves, K. A., Bernhardt, P. E., Burns, J. P., & Lombard, M. K. (2009). Transforming American educational identity after Sputnik. *American Educational History*

Journal, 36(1), 71-87. Retrieved from http://search.proquest.com.ezproxy.libproxy.db.erau.edu/docview/230085627?accountid=27203

Steiner, R. L., & Fox, F. W. (1977). *1978 AETS yearbook - science education: Past or prologue. Glimpses of the past as an aid to the future.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/63833502?accountid=6579

Subramaniam, K. (2013). Minority preservice teachers' conceptions of teaching science: Sources of science teaching strategies. *Research in Science Education, 43*(2), 687-709. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1361838692?accountid=6579

Sumida, M. (2013). Emerging trends in japan in education of the gifted: A focus on science education. *Journal for the Education of the Gifted, 36*, 277-289. http://doi.org.10.1177/0162353213493534

Tarrant, S. P., & Thiele, L. P. (2016). Practice makes pedagogy--John Dewey and skills-based sustainability education. *International Journal of Sustainability in Higher Education, 17*(1), 54-67. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1773216459?accountid=6579

Tatar, E., Tüysüz, C., Tosun, C., & Ilhan, N. (2016). Investigation of factors affecting students' science achievement according to student science teachers. *International*

Journal of Instruction, 9(2), 153-166. Retrieved from https://files-eric-ed-gov.ezproxylocal.library.nova.edu/fulltext/EJ1106343.pdf

Taylor, J. A., Roth, K., Wilson, C. D., Stuhlsatz, M. A., & Tipton, E. (2017). The effect of an analysis-of-practice, videocase-based, teacher professional development program on elementary students' science achievement. *Journal of Research on Educational Effectiveness, 10*(2), 241-271. doi:10.1080/19345747.2016.1147628

Terzian, S. G. (2009). The 1939-1940 New York world's fair and the transformation of the American science extracurriculum. *Science Education, 93*(5), 892-914. doi:10.1002/sce.20329

Therrien, W. J., Benson, S. K., Hughes, C. A., & Morris, J. R. (2017). Explicit instruction and next generation science standards aligned classrooms: A fit or a split? *Learning Disabilities Research & Practice, 32*(3), 149-154. doi:10.1111/ldrp.12137

Tirri, K. (2014). The last 40 years in Finnish teacher education. *Journal of Education for Teaching, 40*(5), 600-609. doi:10.1080/02607476.2014.956545

Timofte, R. S. (2015). Content Analysis of chemistry curricula in Germany case study: chemical reactions. *Acta Didactica Napocensia, 8*(4), 25-31. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1774318714?accountid=6579

Totten, H. L. (2013). The advantages of diversity. *Library Quarterly, 83*(3), 204-206. Retrieved from https://www-jstor-org.ezproxylocal.library.nova.edu/stable/pdf/10.1086/670694.pdf?refreqid=excelsior%3A1a0c704770c29a87336e99ebc9cd9dff

Trimmell, M. D. (2015). *The effects of stem-rich clinical professional development on elementary teachers' sense of self-efficacy in teaching science.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1688752456?accountid=6579

UCL Centre for the Advancement of Learning and Teaching. (2013). Curriculum and instruction. Retrieved from http://www.ucl.ac.uk/calt/support/cpd4he/resources/designing_curriculum/curriculum_introduction

U.S. Department of Education. (2005). Part A — Improving Basic Programs Operated by Local Educational Agencies Retrieved from http://www2.ed.gov/policy/elsec/leg/esea02/pg2.html#sec1115

U.S. Department of Education. (2008). A nation accountable twenty-five year after a nation at risk. Retrieved from https://www2.ed.gov/rschstat/research/pubs/accountable/accountable.pdf

U.S. Department of Education. (2016). Proposed ESSA Regulation Supports Well-Rounded Education, Protects All Students. Retrieved from https://www.ed.gov/news/press-releases/proposed-essa-regulation-supports-well-rounded-education-protects-all-students

Vail, T. M. (2011). *Teachers' professional development experiences: Implications for teaching practice.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/868183694?accountid=6579

Vannest, K. J., Soares, D. A., Smith, S. L., & Williams, L. E. (2012). Progress monitoring to support science learning for all students. *Teaching Exceptional Children, 44*(6), 66-72. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1024596722?accountid=6579

Velthuis, C., Fisser, P., & Pieters, J. (2014). Teacher training and pre-service primary teachers' self-efficacy for science teaching. *Journal of Science Teacher Education, 25*(4), 445-464. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/1651862325?accountid=6579

Walliman, N. (2017). *Research methods: The basics* (2nd ed.). London, UK: Routledge.

Wannarka, R., & Ruhl, K. (2008). Seating arrangements that promote positive academic and behavioural outcomes: A review of empirical research. *Support for Learning, 23*(2). Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/61964453?accountid=6579

Waters, T. L. (2018). *The effects of the next generation science standards (NGSS) on teaching practices: An instrumental case study.* Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/2185944565?accountid=6579

Webb, N. (2007). Issues related to judging the alignment of curriculum standards and assessments. *Applied Measurement in Education, 20*(1), 7-25. Retrieved from http://www.cehd.umn.edu/edpsych/C-BAS-R/Docs/Webb2007.pdf

West-Scoles, C. & Marzano, R. (2015). Examining similarities & differences. Retrieved from https://www.learningsciences.com/media/catalog/product//e/s/esd_lookinside.pdf

Willig, C. (2013). *Introducing qualitative research in psychology* (3rd ed.). New York City, NY: McGraw-Hill.

Wilson, L. O. (2014). *The Instructional Design/Curriculum Development Process*. Retrieved from http://thesecondprinciple.com/instructional-design/instructional-design-process/

Windschitl, M., Thompson, J., & Braaten, M. (2008). Beyond the scientific method: Model-based inquiry as a new paradigm of preference for school science investigations. *Science Education, 92*(5), 941-967. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/61995743?accountid=6579

Worker, S. & Smith, M. (2014). *Curriculum and Professional Development for OST Science Education: Lessons Learned from California 4-H*. Retrieved from http://www.niost.org/Afterschool-Matters-Fall-2014/curriculum-and-professional-development-for-ost-science-education-lessons-learned-from-california-4-h

Yamada, S. (2015). The constituent elements of comparative education in Japan: A comparison with North America. *Comparative Education Review, 59*(2), 234-260. doi:10.1086/680172

Appendix A

Teacher Structure Pre and Post Interview

Teacher Structure Pre and Post Interview

Demographics Survey	
Interview Questions	**Answer**
Below questions will only be asked in the pre interview.	
Identify your gender	
Identify your ethnicity	
Identify your age range (20-29), (30-39), (40-49), (50+)	
Identify your educational level (Bachelors, Masters, Specialist, Doctorial)	
Identify your years of teaching experience	
Identify your science academic background	
What is your experience with the Instructional Design Model regarding generating objectives?	
What is your experience with the Instructional Design Model regarding selecting activities?	
What is your experience with the Instructional Design Model regarding organizing and sequencing activities?	
What is your experience with the Instructional Design Model regarding evaluating?	
What was your understanding of the Instructional Design Model?	
Below questions will only be asked in the post interview.	
In your opinion, what are the strengths of the Instructional Design Model?	
What are the challenges of using the Instructional Design Model?	
Based on your students' pre and post assessment data do you think the Instructional Design Model has anything to do with the scores?	
Would you recommend this Instructional Design Model to other science teachers? Why? Why Not?	
Probes will be used when necessary. All probes will be the same for each teacher.	

Appendix B

Teacher Observation Form

Teacher Observation Form

Seven Focus Areas of Instruction			
Identifying critical content	Yes	No	Comments
Is the teacher providing an opportunity for students to respond and share their understanding of the critical content with the teacher or peers?			
Is the teacher providing the students with key points critical for students to learn?			
Is the teacher monitoring the students to determine if the students understand the critical content?			
Elaborating on new information			
Is the teacher providing an opportunity for students to make a connection between the learning objectives and student experiences?			
Is the teacher providing students an opportunity of organized collaboration?			
Is the teacher monitoring the students to determine if the students can elaborate on new information?			
Recording and representing knowledge			
Is the teacher providing intentional learning experiences for the students to record and represent knowledge?			
Is the teacher monitoring the students as they record and represent new knowledge?			
Is the teacher providing the students with a strategy to record and represent knowledge?			
Examining similarities and differences			
Is the teacher providing intentional learning experiences for the students to examine similarities and differences?			
Is the teacher providing an opportunity for the students to make connections with the topic?			
Is the teacher asking students to explain their thinking or to revise their comparisons?			
Examining errors in reasoning			
Is the teacher providing intentional learning experiences for the students to examine errors in reasoning?			
Is the teacher providing students an opportunity of organized collaboration?			
Is the teacher monitoring of the students to determine if the students can examine their errors in reasoning using evidence from their science text?			
Revising knowledge			
Is the teacher providing intentional learning experiences for the students to revise knowledge?			
Is the teacher providing an opportunity for the students to use technology in revising their knowledge?			
Engaging students in cognitively complex task involving hypothesis generation and testing			
Is the teacher providing intentional learning experiences for the students to			

engage in cognitively complex task involving hypothesis generation and testing through hands on experiences?			
Is the teacher providing an opportunity for the students to have science rich discussions?			
Is the teacher monitoring the students to determine if the students are actively participating in the cognitively complex task involving hypothesis generation and testing?			

Note: The IDM observations are not connected to the teacher's performance evaluations.

Appendix C

Participant Consent Form

General Informed Consent Form
NSU Consent to be in a Research Study Entitled
Investigating the Improvement in Science Achievement among Fifth Grade Science Students when using the Instructional Design Model

Who is doing this research study?

College: Abraham S. Fischler College of Education.

Principal Investigator: Kisha Jarrett, M.Ed

Faculty Advisor/Dissertation Chair: Robert Rose, Ph.D

Site Information: Local School

Funding: Unfunded

What is this study about?

This is a research study, designed to test and create new ideas that other people can use. The purpose of this research study is to find out if using a research model called the Instructional Design Model will improve science test scores. This model is very important because it helps with the delivery of science in the classroom and helps teachers plan more hands-on science activities.

Why are you asking me to be in this research study?

You are being asked to be in this research study because you are a Grade 5 science teacher at the school site.

This study will include about 5 people.

What will I be doing if I agree to be in this research study?

While you are taking part in this research study, you will be asked to participate in 1 professional development session for 2 hours, bi weekly observations for 45 minutes, weekly common planning meetings for 30 minutes, and 2 interviews for 15 minutes.

Research Study Procedures - as a participant, this is what you will be doing:

This study will take place over an eight-week period. The science teachers will be asked to participate in a professional development length of time two hours. The science curriculum for the unit in which the teachers are using Instructional Design Model will remain the same to teach one eight-week unit. During the eight weeks there will be weekly planning meeting in length 30 minutes each. Teacher will be observed four times each in length of 45 minutes. The teacher/classroom observations are NOT connected to your performance evaluations in iObservation. The teachers will also be asked to participate in two interviews (pre and post) for 15 minutes each.

Are there possible risks and discomforts to me?

This research study involves minimal risk to you. To the best of our knowledge, the things you will be doing have no more risk of harm than you would have in every day. Although all study interactions are those that are normally part of regular classroom activity, teachers may feel minor discomfort when being interviewed and being observed in the classroom. The risks are possible loss of privacy and confidentiality of individual participant data. To ensure data security I will use the following measure: I will store the study data and files on an external hard drive that is password protected. The researcher will only have access to the study data and files. Participants' pre/post interview documents and consent forms will be kept in a locked box that only the researcher will have a key to access the documents.

What happens if I do not want to be in this research study?

You have the right to leave this research study at any time, or not be in it. If you do decide to leave or you decide not to be in the study anymore, you will not get any penalty or lose any services you have a right to get. If you choose to stop being in the study, any information collected about you **before** the date you leave the study will be kept in the research records for 36 months from the conclusion of the study, but you may request that it not be used.

What if there is new information learned during the study that may affect my decision to remain in the study?
If significant new information relating to the study becomes available, which may relate to whether you want to remain in this study, this information will be given to you by the investigators. You may be asked to sign a new Informed Consent Form, if the information is given to you after you have joined the study.

Are there any benefits for taking part in this research study?

There are no direct benefits from being in this research study. We hope the information learned from this study will provide you with a hands-on approach in plan and teaching science in Grade 5 that will result in higher student achievement.

Will I be paid or be given compensation for being in the study?

You will not be given any payments or compensation for being in this research study.

Will it cost me anything?

There are no costs to you for being in this research study.

How will you keep my information private?

Your responses are anonymous. Information we learn about you in this research study will be handled in a confidential manner, within the limits of the law. The classroom observations and interview will not include teacher names. Each teacher will be given a number for the classroom observations and be referred to as the assigned number on all documents. This data will be available to the researcher, the Institutional Review Board and other representatives of this institution. All confidential data will be kept securely. The risks are possible loss of privacy and confidentiality of individual participant data. To ensure data security I will use the following measure: I will store the study data and files on an external hard drive that is password protected. The researcher will only have access to the study data and files. Participants' pre/post interview documents and consent forms will be kept in a locked box that only the researcher will have a key to access the documents. All data will be kept for 36 months from the end of the study and destroyed after that time by the researcher by shredding.

Will there be any Audio or Video Recording?

This research study involves audio recording. The recording will be kept and stored as stated in the section above. All audio recoring will be kept for 36 months from the end of the study and destroyed after that time by the researcher by shredding.

Because what is in the recording could be used to find out that it is you, it is not possible to be sure that the recording will always be kept confidential. The researcher will only work on the research paper at home and try to keep anyone not working on the research from listening to or viewing the recording.

I have voluntarily allowed audio recording of the pre and post interview.

Printed Name of Participant	Signature of Participant	Date

Whom can I contact if I have questions, concerns, comments, or complaints?

If you have questions now, feel free to ask us. If you have more questions about the research, your research rights, or have a research-related injury, please contact:

Primary contact:
Kisha Jarrett, can be reached at XXX-XXX-XXXX

If primary is not available, contact:
Robert Rose, Ph.D. can be reached at XXX-XXX-XXXX

Research Participants Rights
For questions/concerns regarding your research rights, please contact:

Institutional Review Board
Nova Southeastern University
(954) 262-5369 / Toll Free: 1-866-499-0790
IRB@nova.edu

You may also visit the NSU IRB website at www.nova.edu/irb/information-for-research-participants for further information regarding your rights as a research participant.

All space below was intentionally left blank.

Research Consent & Authorization Signature Section

Voluntary Participation - You are not required to participate in this study. In the event you do participate, you may leave this research study at any time. If you leave this research study before it is completed, there will be no penalty to you, and you will not lose any benefits to which you are entitled.

If you agree to participate in this research study, sign this section. You will be given a signed copy of this form to keep. You do not waive any of your legal rights by signing this form.

SIGN THIS FORM ONLY IF THE STATEMENTS LISTED BELOW ARE TRUE:

- You have read the above information.
- Your questions have been answered to your satisfaction about the research.

Adult Signature Section

I have voluntarily decided to take part in this research study.

Appendix D

Qualitative Phenomenological Professional Development

Professional Development

At the first available and permissible meeting for a researcher to attend, the researcher will facilitate a two-hour professional development meeting (Appendix D) for the teachers regarding the Instructional Design Model and the research process.

Good Day,

You are invited to attend an interest meeting regarding a research study for my doctoral program at Nova Southeastern University. This is a research study, designed to test and create new ideas that other people can use. The purpose of this research study is to find out if the Instructional Design Model will improve science achievement. This model in science class is very important for students so they can have hands-on experience to compliment the teaching of science concepts.
While you are taking part in this research study, you will be asked to participate in 1 professional development session for 2 hours, bi-weekly observations for 45 minutes, weekly common planning meetings for 30 minutes, and 2 interviews for 15 minutes.
Research Study Procedures - as a participant, this is what you will be doing:
This study will take place over a nine-week period. The science teachers will be asked to participate in a professional development length of time two hours. The science curriculum for the unit in which the teachers are using the Instructional Design Model will remain the same to teach one eight-week unit. During the eight weeks, there will be a weekly planning meeting in length 30 minutes each. Teachers will be observed four times each in length of 45 minutes. The IDM observations are not connected to the teacher's performance evaluations. The teachers will also be asked to participate in two interviews (pre and post) for 15 minutes each.
This research study involves minimal risk to you. To the best of our knowledge, the things you will be doing have no more risk of harm than you would have in every day. Although all study interactions are those that are normally part of regular classroom activity, teachers may feel minor discomfort when being interviewed and being observed in the classroom. The risks are possible loss of privacy and confidentiality of individual participant data. To ensure data security I will use the following measure: I will store the study data and files on an external hard drive that is password protected. The researcher will only have access to the study data and files. Participants' pre/post interview documents and consent forms will be kept in a locked box that only the researcher will have a key to access the documents.

Date: 1/9/2019
Time: 2:00pm
Location: Science Lab

In this meeting, we will discuss the study in detail, distribute consent forms, and answer any questions you may have.

During the professional development the teachers will gain knowledge regarding the Instructional Design Model components, the teacher observation, and common planning expectations. The participants will receive a copy of the presentation notes (below).

Section 1. Introduction

· Introduce the study explaining the purpose of the study.
· Discuss the participants.

Section 2. Instructional Design Model

· Explain the Instructional Design Model and the components.
· Explain how these components align with the observation.

Section 3. Observation

Discuss with the teachers how they will be observed based on the Instructional Design Model.
Identifying critical content
· Identify the critical content by using the Next Generation Sunshine Standard and Grade 5 Item Specifications.
· Provide students with key points of the critical content for students to learn through a daily learning goal.
· Monitoring of the students to determine if the students are understanding the critical content by use of monitoring strategies.
Elaborating on new information
· Assist students to make connections between the learning objectives and student experiences.
· Provide students the opportunity to collaborate with others in the class.
· Monitoring of the students to determine if the students are elaborating new information by use of monitoring strategies.
Recording and representing knowledge
· Assist students with activities and strategies for the students to record and represent knowledge.
· Monitoring of the students as they record and represent new knowledge by use of monitoring strategies.
Examining similarities and differences
· Provide activities for the students to examine similarities and differences.
· Assist students with opportunities for students to make connections with the activity and the critical content.
· Assist students in explain their thinking or to revise their comparisons
Examining error in reasoning.
Provide activities for the students to examine errors in reasoning and opportunity for them to collaborate.

Revising knowledge

· Provide activities for the students to revise their knowledge and use technology.

Engaging students in cognitively complex task involving hypothesis generation and testing

· Provide opportunity for the students to engage in cognitively complex task involving hypothesis generation and testing through hands on experiences.

· Assist students with rich discussions.

Section 4: Assessments (Common Assessment)

· The connection between standards-based learning and standards aligned assessment.

I would like to thank you for taking time to learn about the research study. I will be reaching out to you after the professional development for an interview.

Note: The IDM observations are not connected to the teacher's performance evaluations.

Appendix E

Parent or Guardian Letter and Consent Form

Parent or Guardian Letter

(date)

Dear Parents,

I am writing to invite your child to participate in a research study I am conducting to complete my doctoral degree. I believe this research is important to assist in increasing hands-on experiences in science at the 5th grade level. The purpose of the study is to determine the degree to which the use of Tyler's Instructional Design Model in Grade 5 science classes in the target district will affect student achievement in science. It is hoped that this will increase test scores in grade 5 science at Rosemont Elementary School .

A parent consent form is attached for your approval.

Should you have any questions regarding the study, you are welcome to email

jarrettw@nova.edu. Thank you!

Regards,

Kisha Jarrett

Attachments:

Parental or Guardian Consent Form

Parent/Guardian or Legally Authorized Representative (LAR)
Informed Consent and Adolescent Assent Form
NSU Consent/Assent to be in a Research Study Entitled
Improving Science Achievement among Fifth Grade Science Students
by using the Instructional Design Model

Who is doing this research study?

College: Abraham S. Fischler College of Education.

Principal Investigator: Kisha Jarrett, M.Ed

Faculty Advisor/Dissertation Chair: Robert Rose, Ph.D

Site Information: Rosemont Elementary School

Funding: Unfunded

What is this study about?

This is a research study, designed to test and create new ideas that other people can use. The purpose of this research study is to find out if using a research model called the Instructional Design Model will improve science test scores. This model is very important because it helps with science in the classroom and helps teachers plan more hands-on science activities.

Why are you asking me to be in this research study?

Your child is being asked to be in this research study because he/she is a 5th grader at the Rosemont Elementary.

This study will include about 98 people.

What will I be doing if I agree to be in this research study?

While your child is taking part in this research study, he/she will participate in 8-weeks of science lessons 45 minute per class, PLUS two 25 question tests.

Research Study Procedures - as a participant, this is what your child will be doing:

He/she will be doing the standard procedures for science class that he/she would have done, even if he/she were not in the study. That is, participating in class 45 minutes every day and take two tests.

Are there possible risks and discomforts to me?

This research study involves minimal risk to your child. To the best of our knowledge, the things he/she will be doing have no more risk of harm than what he/she does in science class everyday.

What happens if I do not want to be in this research study?
Your child has the right to leave this research study at any time or refuse to be in it. If your child decides to leave or you do not want your child to be in the study anymore, your child will not get any penalty or lose any services you have a right to get. If your child chooses to stop being in the study before it is over, any information about your child that was collected **before** the date you leave the study will be kept in the research records for 36 months from the end of the study and may be used as a part of the research.

What if there is new information learned during the study that may affect my decision to remain in the study?
If significant new information relating to the study becomes available, which may relate to whether you want your child to remain in this study, this information will be given to you by the researcher. You may be asked to sign a new Informed Consent Form, if the information is given to you after your child joined the study.

Are there any benefits for taking part in this research study?
There are no direct benefits from being in this research study. We hope the information learned from this study will help teachers increase hands on activities through planning and preparation.

Will I be paid or be given compensation for being in the study?

You or your child will not be given any payments or compensation for being in this research study.

Will it cost me anything?

There are no costs to your child for being in this research study.

How will you keep my information private?

Information we learn about you in this research study will be handled in a confidential manner, within the limits of the law and will be limited to people who have a need to review this information. In order to protect privacy, the student's names will not be used. If we publish the results of the study in a scientific journal or book, we will not identify your child.

What Student/Academic Information will be collected and how will it be used?
The following information will be collected from student educational records test data from the pretest and posttest of the school data not individual students. These records will be used to determine if the increase in science scores were due to the Instructional Design Model.

Whom can I contact if I have questions, concerns, comments, or complaints?

If you have questions now, feel free to ask us. If you have more questions about the research, your research rights, or have a research-related injury, please contact:

Primary contact:
Kisha Jarrett, M.Ed can be reached at XXX-XXX-XXXX.

If primary is not available, contact:
Robert Rose, Ph.D can be reached at XXX-XXX-XXXX.

Research Participants Rights
For questions/concerns regarding your research rights, please contact:

Institutional Review Board
Nova Southeastern University
(954) 262-5369 / Toll Free: 1-866-499-0790
IRB@nova.edu

You may also visit the NSU IRB website at www.nova.edu/irb/information-for-research-participants for further information regarding your rights as a research participant.

All space below was intentionally left blank.

Research Consent & Authorization Signature Section

Voluntary Participation - You are not required to participate in this study. In the event you do participate, you may leave this research study at any time. If you leave this research study before it is completed, there will be no penalty to you, and you will not lose any benefits to which you are entitled.

If you agree to participate in this research study, sign this section. You will be given a signed copy of this form to keep. You do not waive any of your legal rights by signing this form.

SIGN THIS FORM ONLY IF THE STATEMENTS LISTED BELOW ARE TRUE:
- You have read the above information.

Your questions have been answered to your satisfaction about the research