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Exploring the Meaning and Use of Science Content Integration

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COLLEGE OF EDUCATION

This is to certify that the doctoral study by

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2012

Abstract

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MS, Walden University, 2008

BS, Georgia State University, 2000

Doctoral Study Submitted in Partial Fulfillment

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Abstract

Science content integration, or the simultaneous teaching of science with other subjects during learning activities, has been explored by multiple studies. However, due to a lack of consensus on its definition, it was difficult for educators in a local school district to discuss and evaluate the effectiveness of this instructional technique. This qualitative collective case study, based on a constructivist theoretical foundation, centered on the questions of how teachers defined and used science content integration, and perceptions of impediments to its use. Participants were five teachers in a suburban elementary school. The sources of data for this study were interviews, audio recordings of lessons, and teacher documents in the form of lesson plans. Data analysis was conducted through multiple coding procedures, allowing the emergence of themes. Data analysis showed that participants' beliefs and practices differed according to age levels and developmental needs of their students. Implications for positive social change include building from this study to provide content integration-based professional development, common planning time, and suitable materials to improve teachers' capacity to integrate science content into instruction.

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Dedication

This study is dedicated to my grandmother, Mary Lee Garner. Thank you for giving me the foundation I needed to be successful and make a positive contribution to society. I hope and pray that your legacy will live through me, and that I may bless my grandchildren as you have blessed me. I thank God for you every day.

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Section 1: Introduction to the Study

Introduction

The No Child Left Behind Act of 2001 requires schools to meet Adequate Yearly Progress (AYP) in math and reading. Because of the pressure to meet AYP, schools focus their attention on instruction in math and reading (Keeley, 2009), and are very focused on the support of school attendance. However, an adverse effect of this practice is that other subjects like science fall away from top priority. Time and resources are taken away from the teaching of science while more time is spent on reading and math. Consequently, quality science instruction in the United States is not being provided to many students (Berliner, 2009; Fry, 2009; Keeley, 2009; Owens, 2009).

According to Fry (2009), instructional focus and resources devoted to content-area curriculum subjects such as science and social studies were already in decline prior to the passage of NCLB, but the passage of the law led to even greater reductions (p. 32). Because of this decrease in emphasis on science instruction (Keeley, 2009; Lawrence, 2007; Lee, 2007; Owens 2009), there has been a steady decrease in the amount of resources used for science and science instruction in the elementary school. These resources include instructional time, as well as material and financial resources (Fry, 2009, p. 32).

According to Griffith and Scharmann (2008), in order for students to experience success in scientific learning during middle school and high school years, it is imperative that they be provided a strong foundation in formative early years (p.44). As such, the current trend in science learning is detrimental to students (Fry, 2009; Griffith & Scharmann; Owens, 2009). The effects of the reduced time allotments are revealed in test scores. Numerical test score data reveal an overall deficiency in scientific knowledge and learning (Lawrence, 2007; Owens, 2009).

A positive change in practice can occur through *integration,* which I operationally define for the purposes of this study as teaching standards belonging to different content areas (e.g., science and mathematics) simultaneously (Marklin & Wood, 2007; Virtue, Wilson, & Ingram, 2009). Content integration in schools has been occurring since the early 1900s, when the concept was first pioneered by John Dewey (Dowden, 2007). However, according to Lee (2007), not many teachers have the time to plan integrated learning experiences, nor do they have the training to integrate effectively. A specific obstacle to effective integration is a lack of consensus on how content integration should be defined and implemented (Dowden, 2007; Meyer, Stinson, Harkness, & Stallworth, 2010; Stinson, Harkness, Meyer, & Stallworth, 2009; Virtue et al., 2009).

Though the effectiveness of content integration has been explored through other research, (e.g., Alexander, Walsh, Jarman, & McClune, 2008; Höhn, & Harsch, 2009; Kinniburgh, & Busby, 2008; Reed, & Groth, 2009), how teachers define science integration and how they use it in their classrooms warrants exploration (Dowden, 2007; Meyer et al., 2010; Stinson et al., 2009). An exhaustive search for data regarding elementary science instruction and content integration in suburban Georgia yielded no results.

The goal of this study is to investigate the nature of science instruction provided in a suburban Georgia elementary school. Teaching science effectively at the elementary level can be difficult, especially for teachers in the state of Georgia because of the scope and sequence of state standards (Lawrence, 2007). This difficulty is revealed in test results as students within a school in Georgia are receiving lower scores than expected on the Science subtest of the Georgia Criterion Referenced Competency Test (CRCT).

This is a collective case study, with the cases being five different teachers' reportsof their science content pracitices. The teachers who participated in this study teach different populations of students, have received different training, and come from different backgrounds. Their perspecitves and practices constitute this study's data.

Definition of the Problem

Data show that approximately one-fifth of Georgia's students in Grades 3-5 did not receive a passing score on the science subtest of the Georgia CRCT in 2010 (Georgia Department of Education, 2010). Research suggests that integration can be effective in increasing achievement (Alexander et al., 2008; Bergmann, 2008; Card, 2005; Lawrence, 2007; Reed & Groth, 2009). It is currently unknown how science integration is defined and being used in Georgia classrooms. A lack of awareness on this issue may be depriving students of receiving high-quality science instruction. Understanding how teachers define and use content integration will pave the way for professional development that will ensure effective educational experiences for children.

This problem manifests locally in a very important way. Iosova (2010) wrote that Georgia is one of the top ten states with regard to growth (p. 66). Iosova also stated that the way that Georgia calculates funding for education is based upon student enrollment rather than other more commonly used formulas. Though teacher pay is thirteenth in the nation, Georgia has a high teacher attrition rate, as one-third of all teachers leave the profession within the first three years (Iosova, 2010).

Because funds must be allocated towards teacher training, induction, and preparation, reducing teacher attrition would save money, which could otherwise be used to improve existing practices. One factor that may contribute to attrition is teacher dissatisfaction and frustration with the difficulties of teaching science. Perrachione, Petersen, and Rosser (2008) reported that teacher pay had a much lower impact on teacher satisfaction than other factors. Lawrence (2007) wrote that science especially was a difficult subject to teach, and especially in Georgia. Though the attrition rate reported by Iosova (2010) does not refer to science teachers specifically, perhaps the effects and causes of the attrition rate could be nullified through the support of science content integration. Teacher training and support has the potential to increase teacher satisfaction in the workplace (Gardner, 2010; Perrachione et al., 2008).

Findings provided by this study increased the knowledge base regarding science learning in the state of Georgia. However, was local in that test scores at a local school indicated a need for improvement in student science performance. This fact, coupled with research exposing a national trend regarding deficiencies in science education, supported this subject as a valid topic of study. One specific school within suburban Georgia area was the situational point for this study.

Nature of the Study

This study addresses the following questions:

1. How do teachers individually define science integration?
2. How do teachers use science integration in their classrooms?
3. What do teachers report as impediments to content integration?

This study was a collective case study (Creswell, 2007). There were five participants, intentionally selected (Creswell, 2007) to represent specific demographics within the local elementary science education community. Creswell stated that there is no set number of participants in a collective case study, but that the beginning researcher should choose fewer than six (p. 76). All participants were from the same school, which is part of a school system in the suburban Georgia, and who claim to currently practice content integration. An interview protocol (Appendix A) of five open-ended questions guided the discussion (Creswell, 2007; Rubin & Rubin, 2005). Other data sources were documents in the form of lesson plans and transcripts of audio recordings.

Multiple forms of data were gathered to explore this topic (Johnson & Bonaiuto, 2008). Preble and Taylor (2008) wrote:

> When it comes to data, educators need to think about a broader spectrum of evidence than test scores. They also need data that enable them to see deep into the heart and soul of their schools and the lives of their students. (p. 40)

Schools need to "look beyond quantitative data" (Johnson & Bonaiuto, 2008, p. 28) by not only examining the test scores, but also investigating teacher input. Swan (2009) wrote that these forms of data (i.e., interviews, teacher comments) should be the driving force behind leadership decisions regarding professional development and resource allocation.

Data analysis and data collection were conducted concurrently (Hatch, 2002). Validation was established through member-checking and triangulation (Creswell, 2007, p. 208). Triangulation involved using different sources of data for data collection so that the issue can be examined from different viewpoints (Baxter & Jack, 2008). Baxter and

Jack wrote that the member checking process was “where the researchers’ interpretations of the data are shared with the participants, and the participants have the opportunity to discuss and clarify the interpretations, and contribute new or additional perspective on the issue under study” (p. 556). Near the end of data analysis, I met with participants to share my findings, code, and themes. Their opinions regarding my findings are reported in Section 4. A more detailed discussion of methodology is presented in Section 3.

Purpose of the Study

This study did not seek to investigate whether or not content integration is effective. Rather it sought to explore how teachers in a single elementary school in suburban Georgia school defined and used integration. Stinson et al. (2009) and Meyer et al. (2010) found that there were many interpretations of the meaning and appropriate use of content integration. Stinson et al. and Meyer et al. identified the following forms of content integration: (a) process integration, where a skill in one are area of the curriculum is applied in another area of the curriculum; (b) pedagogical integration, where skills and knowledge in a curricular area are used in the context of another area, such as making an analogy; (c) thematic integration, where an overarching theme is used to connect all areas of learning; (d) inter-discipline integration, where skills within one area are integrated; (e) project-based integration, where skills in multiple areas are used simultaneously in the completion of a project; and (f) simultaneity, where different concepts are taught together because they are dependent upon one another.

Through a qualitative investigation, out of the data emerged themes revealing how teachers in a suburban Georiga school define and use science integration, as well as impediments to its use in their classroom. Discovering which approach to science instruction is the most effective was beyond the scope of this study. However, the data from this study may be applied to related studies in the future.

Conceptual Framework

This study centered upon the exploration of science content integration in elementary schools. Though this issue is not confined to a single local school in suburban Georgia, the local manifestation of the issue warranted an investigation. While Owens (2009) wrote that the tasks related to teaching science can be challenging, it can be especially difficult in the state of Georgia (Lawrence, 2007). Lawrence wrote that teaching science in Georgia was difficult for teachers due in part to the scope and sequence of the state science curriculum in addition to factors affecting other states, such as time constraints due to NCLB. Not only might the use of integration prove to be an effective way to increase student achievement, but it might also enhance teachers' feelings of effectiveness and job satisfaction (Hodges & Tippins, 2009). Gardner (2010) identified that one way to prevent attrition is to raise the level of teacher satisfaction.

Teachers who feel more confident in their ability to reach the needs of students are more likely to remain in their current position (Boe, Cook and Sunderland, 2008; Gardner, 2010). Boe et al. (2008) found that in comparison to pursuing other careers, pregnancies, sabbaticals, retiring, leaving for a better salary, leaving because of family issues or other concerns, the greatest percentage of teachers who leave the profession are simply dissatisfied with the career (p. 18). In their qualitative research, Perrachione et al. (2008) found that one of the largest factors that contributed to teacher dissatisfaction and attrition was "role overload" (p.36). The potential of integration to maximize instructional time in the classroom may reduce the effects of what Perrachione et al.

identified as a contributing factor to educator dissatisfaction. The potential of content integration to increase the overall use of limited resources in education, such as time and funds, warrants exploration. Prior to these investigations, the first step is to examine the current use and meaning of content integration.

This study is a collective case-study. Five, purposefully selected (Creswell, 2007) teachers were the focus of the study (p.76). Through a combination of interviews, observations and documents, including video footage and lesson plans, data were gathered that explores how these teachers define and use integration. An additional question, concerning what teachers perceived as impediments to content integration, was also explored using the same data sources.

Different themes emerged from the coding process (Creswell, 2007; Hatch 2002). Following the suggestion of Hatch (2002), I used computer-assisted data analysis. Using NVivo 9 software, enabled data collection and retrieval to occur in a time-efficient manner, while at the same time enabling the accurate categorization of data. Lastly, to establish validity of the work, member checking and triangulation was utilized (Creswell, 2007). Baxter and Jack (2008) wrote that member checking and triangulation are among the most commonly used methods in qualitative research used to establish trustworthiness of the findings and conclusions (p. 556). Baxter and Jack describe triangulation as using multiple data sources, researcher, or data types (p. 556). For this study, different sources of data were used: interviews, lesson plan documents, and video recordings. Member checking consisted of meeting with the participants after the data collection and analysis phases and discussing the findings (Baxter, & Jack, 2008; Creswell, 2007; Yin, 1994). Prior to data analysis, I did not know if the participants would agree with my research findings. I anticipated challenge of codes and themes from members, however, this did not occur. For major issues, I would have returned to the data collection and analysis phases.

Approximately 20% percent of students are not achieving expectations (i.e. scoring Level 2 or 3) on the science subtest of the CRCT. Therefore, if science content integration's implementation can assist teachers in meeting the difficult demands of teaching science in the state of Georgia (Lawrence, 2007), then it was first necessary to understand how this practice is defined and utilized. The findings of the study, as well as the emergent themes that were derived from the study's data are presented in Section 4.

Operational Definitions

The following definitions and terms were used in this study:

Content integration: There is not yet consensus regarding the definition of content integration in the research literature (Dowden, 2007). For purposes of this study, content integration refers to any activity or lesson that addresses objectives from more than one curricular area (i.e., math, science, language arts, etc.) simultaneously.

CRCT: The Georgia Criterion-Referenced Competency Test is given to students of various grade levels in the state of Georgia. Students are given several subtests of this test, and may score in any of three levels. The lowest level (i.e. "level one") is considered failing while the highest level is considered above grade-level performance.

Local school: Local school is the term that is used to refer to the school in which the participants are employed. This school is situated in suburban Georgia.

Assumptions, Limitations, Scope and Delimitations

Scope

This study was focused on a small number of elementary teachers in the suburban Georgia, so no conclusions were drawn about teachers outside suburban Georgia or in other grade levels. Additionally, though the study was focused on content integration within the curriculum, it was focused on the integration of science with other subjects. The study did not include examination of numerical data and it did not address which types of integration are the most effective. Comparing traditional instruction with integrated instruction was beyond the scope of this study.

Delimitations

There were exclusionary and inclusionary delimitations in this study. The inclusionary focus was on gathering a group of participants from the population of science educators employed within suburban Geogia. This sampling excluded teachers employed by systems outside of this area, educators not working in an elementary school, and those who did not teach science. This study included qualitative data relative to human perception, but excluded the gathering of numerical test data.

Assumptions

Prior to the implementation of the study, the following details were assumed: (a) Participants had received pedagogical education at a college or university prior to receiving licensure to teach; (b) interview participants would provide candid and honest responses; and (c) no teachers participating in the study were currently participating in any identical studies.

Limitations

The most prominent limitation of this study was its design. The purpose of this study was to examine and explore how teachers in a suburban Georgia school define and use science content integration. Test scores were not examined as a source of data. The study was focused on subjective viewpoints and the meaning that educators attach to their experiences (Creswell, 2007) regarding the operational definition and use of content integration.

This study involved interviews with teachers, document review and an analysis of trends, themes and anomalies with a small purposeful sample (Creswell, 2007) of five teachers within the population of Georgia educators. The data came from educators in a single school in a suburban Georgia area.

For this study, I chose among teachers whom I personally knew through involvement in professional development programs, courses, science education seminars and those who are colleagues of my associates and fellow employees. This limited the participants to those individuals who are more involved in professional development and leadership. This type of sampling directly limited the scope of the study.

Significance of the Study

This study was significant because it focused on an individual instructional practice in a suburban Georgia school. Additionally, it was concerned only with sicence content integration, rather than content integration in general. The findings of the study can be used to influence local decisions concerning instructional improvement. Some educators consider science content integration to be a powerful tool in maximizing instructional time and teaching children in a constructivist format, thus making instruction more effective (Dowden, 2007; Gordon, 2009; Lee, 2007). According to many incarnations of content integration, there is an underlying connection to constructivism and project-based learning (Lee, 2007). However, it is currently unknown what meaning educators ascribe to the term *integration*. This term can have many meanings, and the practice of science content integration can be implemented in multiple ways.

Furthermore, through this study, local and state policy-makers can use teacher input to guide further practice and inquiry. This study was unique because it added to the existing body of knowledge concerning science instruction and the integration of content subjects, but specifically at the elementary level, and specifically within the state of Georgia. For this reason, this study was applicable to the improvement and development of instructional practices for elementary teachers in suburban Georgia.

According to Furner and Kumar (2007), the implementation of content integration requires training and the allocation of time. This effort is sure to carry a financial expense, and some critics, such as McGlynn (2007) have warned that the expense is not worth it, given the results as seen in the academic performance of students in the U.K. Berlin and White (2010) stated that even with training, some teachers do not make content integration a common practice. However, an investigation regarding potential benefits of content integration was premature. What was first needed was an exploration into the definition and use of this instructional technique, specifically centered on elementary science education within the metropolitan suburban Georgia setting.

Implications for Social Change

Elementary education is facing a profound dilemma. There is a deficiency in providing students the science knowledge and skills they need to be able to achieve academically and develop into effective, self-sustaining adults (Lawrence, 2007; O'Toole, 2010; Owens, 2009). Understanding the current uses of content integration will support administrators, teacher-leaders, and policy-makers in tailoring the practice of content integration to meet the needs of specific systems, schools, and student populations. This could lead to a local positive change in that it will contribute to the body of knowledge regarding science content integration localized within suburban Georgia. Fry (2009) warned that students in teacher-preparation courses will be unable to practice what they have learned about science education in student teaching experiences because of the narrow focus on math and reading resulting from NCLB. Fry stated that these teachers will face a "gap" between knowledge and practice (p. 32). In order to prepare teachers for the demands of the profession, institutions must understand which instructional methods are most effective. Therefore, understanding the definition and current use of integration was a precursor to examining the effectiveness of this instructional practice.

Though NCLB has effectively taken time and attention away from science instruction (Keeley, 2009; Owens, 2009), this study explored the potential of teachers to bring it back. While the integration of science with math, reading and other subjects has the potential to raise test scores and increase achievement (Alexander et al., 2008; Bergmann, 2008; Card, 2005; Lawrence, 2007; Reed, & Groth, 2009), the greatest benefit to students comes long after the school day has ended. Lee (2007) stated, "Students cannot conceivably be prepared for every situation. Students who have experience applying what they have learned to several content areas will be better prepared to transfer knowledge later in their lives" (p.159). When students are taught through an integrated curriculum, they not only gain knowledge but also the skills needed to apply knowledge in solving problems and thinking critically (Dowden, 2007; Owens, 2009). However, without a common definition or an understanding of the current practices, it would be difficult to improve science instruction for Georgia's students. In order for schools to implement integration, the current practice of content integration needed to be explored and understood.

Summary and Transition

Schools in Georgia are focusing on math and language arts rather than science to achieve higher results on the core areas of the CRCT (Lawrence, 2007). Research supports the notion that because science content is not part of AYP, science instruction is not given time, resources, and adequate instructional focus to prepare students for the future (Dowden, 2007; Lawrence, 2007; Lee, 2007). According to Fry (2009), instructional time and other resources allotted for science instruction was in decline prior to the passage of NCLB. The passage in the law resulted in an even greater cut. Recent data made available to the public in the State of Georgia reveals that approximately 20% of students in Grades 3-5 are not meeting expectations in science, as indicated by the Georgia CRCT. According to Lee (2007) students need access to learning activities that prepare them for their future lives as adults.

Lawrence (2007) supported the use of content integration to meet state standards with regards to science instruction. Using content integration as an instructional tool could prove to be highly effective in meeting the demands of a rigorous curriculum in science (Dowden, 2007; Lawrence, 2007; Lee, 2007). Content integration has its roots in the work of John Dewey and early constructivists (Dowden, 2007). However, there are some problems with the implementation of content integration. Lee (2007) wrote that many instructors are deficient in both time and skills to integrate properly. Additionally, there is not a universal definition as to what it is, nor a consensus on how it should be applied (Dowden, 2007; Meyer et al., 2010; Stinson et al., 2009; Virtue et al., 2009). The lack of a common definition and mode of application of content integration may be providing an impediment to high-quality science instruction (Alexander et al., 2008; Bergmann, 2008; Card, 2005; Lawrence, 2007; Reed, & Groth, 2009).

This study sought to explore how teachers in the suburban Georgia schools define and use content integration. The approach of this study is a collective case study, relying on data gathered from five participants in the form of interviews, documents in the form of lesson plans, and audio recording of learning activities. The study sought to answer the questions, (a) How do elementary school teachers in suburban Georgia define science content integration? (b) How do elementary school teachers in a suburban Georgia school use science content integration? And (c) What impediments to integration exist and how can these impediments be eliminated? The objective of the study was to explore the answers to these questions in a qualitative format. Though different effective validity-checking strategies exist (Creswell, 2007), this study used member checking and triangulation of multiple sources of data. Section 2 of this study provides an in-depth review of literature related to the problem, as well as the findings of other studies that have investigated similar issues in education. Section 3 of this study presents the methodology that was used to conduct the study. Section 4 consists of the data analysis from the multiple sources, representing the participants' individual uses and definitions of science content integration. Section 5 presents the findings of the study, answers to the research questions, practical applications of the study's findings, and suggestions for future studies.

Section 2: Literature Review

Introduction

I conducted an exhaustive search using Walden University's research databases as well as books, articles, etc. For electronic searches, some of the search terms were *integration*, *constructivism*, *teaching*, *education*, *elementary*, *science*, and *Georgia education*. The databases used for the retrieval of literature were ERIC, Education Research Complete, and Sage. These databases were available through the Walden University Library. Some of these terms were combined with other terms to locate articles that related to more than one search term. After an initial investigation of literature, I concluded that there was a problem in identifying exactly what content integration is and how it is applied in classrooms today to meet the needs of students. I found that this problem is a national trend but that it also has a direct local application with regards to teacher satisfaction and attrition (Hodges & Tippins, 2009; Iosova, 2010). After investigating the problem with regards to integration, I conducted research on different research methodologies and found the qualitative case study to be the best option for investigating this problem.

The research is presented here in a specific format. First, I discuss what the literature states regarding the impact of NCLB on science instruction. Then, I describe what research states about the general practice of content integration and how it can reduce some of the negative impacts from NCLB. I then describe the problem with defining integration, as supported by literature. Prior to presenting the theoretical framework of the study, I present what the literature states about why the practice of integration is not more common among educators.

This study does not attempt to prove or disprove the effectiveness of integration. The overall purpose is to investigate the issue of defining integration for the educators in suburban Georgia. I have found a gap in research regarding how science content integration is used and defined in Georgia suburban schools. This study attempts to address that gap with applicable qualitative findings.

NCLB's Effects on Science Instruction

No Child Left Behind has had a great impact on science instruction in elementary schools (Berliner, 2009; Keeley, 2009; Owens, 2009). Keeley (2009) stated that because some schools are having difficulties in meeting math and reading testing requirements, science is not taught at all. Berliner (2009) wrote that because of the current law, schools are spending less time on subjects like science and social studies. According to Keeley (2009) and Berliner (2009), this trend in science education does a true disservice to children, as it does not provide them with adequate exposure to science knowledge and skills.

Though teachers do not currently have the power to change the curriculum standards in their local schools they do have the power to adjust how those standards are taught (Dowden, 2007). Owens (2009) commented on the current law:

> While NCLB was passed by the Bush administration under a Republican-led Congress, new controversies over the policy are emerging under the new Obama administration and a Democratic-led Congress. Current education policy in the U. S. and the effectiveness of NCLB is a hot topic for debate among politicians and the general public. (p. 49)

Though the current requirements neglect scientific learning, another negative aspect of NCLB is how students are assessed. Berliner (2009) took issue with multiple choice tests used by states in reaction to NCLB. Berliner used the history of China as an example of what can happen to the U.S. if the present trend of assessment and instruction is continued. Berliner (2009) stated that at one time: "China led the world in science and technology. Its scholars looked outside national boundaries, and its tests asked for creative answers-analytic and interpretive answers to questions about the Chinese masters of art and philosophy" (p. 294). Berliner wrote that over time, China ceased to be the economic and scientific superpower that it once was. Berliner linked China's economic decline to a change in Chinese testing that began to value memory over creativity. When science is taught, it is often taught mimetically in preparation for a multiple-choice test rather than through inquiry and problem-solving (Keeley, 2009; Lawrence, 2007; Owens, 2009).

Race to the Top

Some recent changes and developments have targeted an improvement in science instruction. These initiatives were a countermeasure to the unintended effects of NCLB (i.e. decrease of time and material resources for science instruction). One such initiative was President Obama's Race to the Top program (RTTT). Kyung Eun (2011) stated that under RTTT:

> States voluntarily compete for federal funding; successful states demonstrate improvements in the following four educational areas: enhancing standards and assessments building effective use of data systems, retaining and increasing

teacher effectiveness and achieving equity in teacher distribution, and transforming low-performing schools. (p. 101)

Race to the Top was part of the American Reinvestment and Recovery Act of 2009, and has been funded with over 4 billion dollars (Barnes, 2011).

Ungerer (2010) offered criticisms of RTTT being too reliant upon standardized test scores. Additionally, Barnes (2011) criticized RTTT as attempting to “coerce” states to standardize practices, or risk the loss of Title I funding. Barnes wrote that allowing the federal government to have more power over education would not lead to improvements, pointing out that doubling the budget for the U.S. Department of Education over the last 30 years did not lead to educational improvements. The Elementary and Secondary Education Act of 1965, NCLB, and an increase in Title I funding have not led to significant increases in test scores. Therefore, it is not logical to expect that RTTT will succeed where other programs have failed. Barnes (2011) reported, “As evidenced by the history of the federal government in education, more standards, more guidelines and even more money do not necessarily equate to large gains in academic quality or achievement” (p. 401).

RTTT provided potential for a change in science instruction. Whether or not the program will benefit student achievement remains to be seen. The 2001 implementation of NCLB led to a decrease in instructional time, but RTTT has the potential to increase the academic focus on science. For instance, some states are using science as a second indicator for AYP under NCLB. With this practice being the case, it is even more important for schools to look for ways to maximize instructional time, using practices such as content integration (Keeley, 2009; Hodges, & Tippins, 2009).

The Need for Content Integration

According to Keeley (2009), some schools do not teach science, due to NCLB's testing focus on math and reading. This practice is not beneficial to students. Owens (2009) confirmed science to be highly important because it prepares students to think critically, problem solve, and engage in inquiry. Performance of U.S. students, compared to other nations' students, is lacking (Owens, 2009). Data from the Trends in International Math and Science Study (National Center for Education Statistics, 2007) reveals that fourth-grade U.S. students scored below students in Singapore, Chinese Taipei, Hong Kong, Japan, Latvia, England, and the Russian Federation. Though students in England, Latvia, Singapore, and Hong Kong have seen an increase in scores of 14 points or more since 1995, U.S. scores have decreased. The U.S. has a higher gross domestic product (GDP), a metric used to measure the economic health of a nation, than each of the nations that outperformed it (Central Intelligence Agency, 2011). Owens (2009) wrote:

> Accomplishing the goal of improving student science achievement in the United States is necessary in order to increase overall science literacy amongst the U.S. population and ensure preparedness for the growing science and technology demands of the 21st century. (p. 49)

One reason for this phenomenon is that teachers may not be teaching in accordance to how students learn (Lawrence, 2007; Owens, 2009). Owens (2009) stated:

> The effectiveness of science teachers is often measured by the success of the students. In order to ensure student success in science, research about how students learn science and how teachers should be teaching science must be taken into account by policy makers (p.49).

Content integration capitalizes on the natural manner in which students learn (Lee, 2007; Keeley, 2009). Though this practice is an efficient and effective way in which to teach students (Lee, 2007), Furner and Kumar (2007) warned that training is necessary to ensure that the instructional technique is correctly used. McGlynn (2007) offered caution that financial costs associated with teacher preparation to implement content integration might outweigh the potential benefits.

Hayes (2010) warned against an overreliance on a cross-curricular instructional approach. Hayes stated that teachers might not be able to specialize in a way that allows students to experience depth in a particular content area. This practice can be very detrimental to high-level learners and gifted students (Feng, VanTassel-Baska, Quek, Bai, & O'Neill, 2004). However as Dannels, and Housley-Gaffney (2009) commented, some models of integration rely heavily on teacher collaboration. With open and working communication, a lack of adequate exposure to learning objectives is not an issue (Dannels, & Housley-Gaffney, 2009, p. 141).

Science should be taught in a manner that embraces the act of inquiry. Lawrence (2007) instructed that when teaching science, teachers should be "Designing learning opportunities in which students get to act as scientists encourages them to actively participate in a variety of learning experiences, interact with their peers while learning, and make decisions about relevant topics" (p. 37). Owens (2009) cited the important intellectual and thinking skills nourished by science instruction. Owens wrote that with inquiry, "Students improve their problem-solving skills and their abilities to use evidence to formulate explanations" (p. 52). This highlights the importance of science education. Whether or not it is being tested or takes priority on a state-mandated test, students need science.

Even when teachers do have time, science can be difficult to plan, implement and assess. Lawrence (2007) stated that there are many difficulties to Georgia teachers teaching science: (a) Georgia standards have traditionally been extensive in scope; (b) science standards might not be aligned to the developmental needs of students; and (c) science standards might not be aligned to "natural interests" of students (p. 33). These issues highlight the need for greater instructional support and resources for teacher training and professional development in science education. Dowden (2007) stated that instruction, and curriculum, should be centered on the student rather than the subject. According to Owens (2009), better instructional practices in science will bring about better results on science assessments.

An overreaching effort must be made to move our instructional practices toward a more integrated approach and away from "traditional methods" (Furner & Kumar, 2007, p. 185). The practice of integrating subject matter between class periods and blending instructional standards is a sound practice supported by existing research (e.g., Lee, 2007). Marklin and Wood (2007) avowed the ability of integration to assist students in acquiring and using new vocabulary. According to Holloway and Chiodo (2009) integration of subject matter and standards from different subjects into a single approach can be effective in reaching educational goals. Marklin and Wood (2007) supported the use of interdisciplinary planning, where teachers who specialize in different areas work together to plan learning activities for students that embrace standards from different areas of the curriculum (p. 50).

Integrated learning also provides an opportunity for project-based experiences. When students engage in singular activities that target objectives indigenous to separate areas of the curriculum, such as projects, learning is more relevant and students experience better retention (Lee, 2007). Project-based experiences are especially beneficial to gifted students and high-level learners (Lee, 2007). VanTassel-Baska et al. (2009) suggested that it is best to nest project-based learning within relevant social issues. The authors wrote that the major benefit of project experiences is that it allows students to experience learning nestled in inquiry. VanTassel-Baska et al. (2009) stated, “High-ability learners need a curriculum that provides advanced-level work and high-level thinking encourages reflective thinking about real-world issues and problems” (p. 9).

Furner and Kumar (2007) stated that when subjects are integrated students are more motivated and attentive (p. 186). This is perhaps due to the fact that integrated learning targeting student interest is inherently more student-centered (p. 185). Additionally, integrated learning links students’ education to real-world application and problem solving (Youm, 2007). Lee (2007) stated, “When students become interested in a topic that is taught in more than one subject, they are more likely to be motivated and pay attention in these various classes and have a desire to learn” (p. 159). According to research, blending standards within a curriculum is an effective practice for all students, including those who are gifted as well as those with special needs (Cheng et al., 2008; Lee, 2007). VanTassel-Baska et al. (2009) suggested that curriculum integration should be nested within social issues. VanTassel-Baska et al. (2009), along with Mioduser and Betzer (2008), cite the need of students to engage in inquiry. VanTassel-Baska et al. (2009) stated: “Students need a curriculum that provides advanced-level work and high-level thinking encourages reflective thinking about real-world issues and problems” (p. 9). Furner and Kumar (2007) wrote, “Problem-based learning invoking process skills instead of rote learning must become a classroom norm.” (p. 187).

Stinson et al. (2009) asserted that content integration allows for greater retention of knowledge and a higher ability to solve problems. Problem-solving and divergent thinking are skills that students will need to be efficacious citizens in the future (Lawrence, 2007; Lee, 2007; Mioduser, & Betzer, 2008). Practicing content integration benefits students in multiple ways. Feng et al. (2004) stated that an integrated science and language arts program, students will experience increased achievement, test results and retention of knowledge. Furner and Kumar (2007) also wrote that an integrated approach to math and science will yield higher test scores in both subjects (p. 186). Additionally, integrating science and language arts activities improves reading (Feng et al., 2004).

Constructivism, Content Integration and Inquiry-Based Learning

The integration of content began with the early constructivist movement (Meyer et al., 2010; Youatt & Wilcox, 2008). From these early pioneers of content integration, manifestations of applied practice still hold to these historical concepts. Furner and Kumar (2007) stated that the current practice of integration “relates directly to the constructivist approach of hands-on minds-on learning” (p. 186). According to Cuenca

(2011), democratic dialogue is an effective method for teaching in the constructivist classroom. Cuenca cited the early constructivist writings of Bakhtin for these findings.

Bakhtin (1981) criticized traditional modes of teaching where knowledge was transmitted from teacher directly to student. Bakhtin wrote that real learning only took place when knowledge was mutually constructed between two individuals in dialogue (p. 110). Teaching in a constructivist mode involves democratic dialogue, and it is at odds with memorization and recall of facts, often out of context with the students' realities (Baktin, 1981; Cuenca, 2011; Horton, 2008; Matusov, 2007).

A large part of constructivist thought comes from the work of Lev Vygotsky. Vygotsky (1986) wrote that children gained knowledge through social interactions. According to Horton (2008), the work of Vygotsky is one cause for the emergence of collaborative group experiences in classrooms. However, true constructivism calls for more collaboration and naturalistic learning that children acquire on their own, based on what is pertinent and important to them. During the constructivist practice of student collaboration, dialogue plays an important role (Bakhtin, 1981). In these practices, Vygotsky (1986) and Bakhtin (1981) contended that learning should be guided by the interests of students. When, educators teach in a way that is based on high student interest, there are many opportunities for content integration (Lee, 2007). In providing students with educational activities aligned with the suggestions of Bakhtin and Vygotsky, subjects should not be separated but rather blended in adherence to student interest and need. It is the task of the instructor to arouse interest in the standards, thus guiding students to targeted explorations. Cuenca (2011) wrote that collaborative practices, meshing curricular areas with student interest, can be effective in teaching math and reading as well as other subjects.

According to Meyer et al. (2010), in the late 1980s and early 1990s, many organizations, including the National Research Council (NRC) and the National Council for Teachers of Mathematics (NCTM), voiced more support for integrated instruction (p. 154). Dowden (2007) stated, "During the twentieth century, the 'correlation of subject areas' was interpreted as a method for identifying overlaps between subjects which are then eliminated when teachers identify connections between subjects" (p. 57). In the same way that a child's perception of the world is not separated into different subject classifications, the approach to learning could also be an integrative experience. According to Lamanauskas (2010), integrated curriculum should be centered on the "skills, aptitudes and interests" of the child (p. 8). Learning activities designed in this manner offer greater support to student self-reliance and independent learning (Lamanauskas, 2010, p. 9).

By assisting students in perceiving these connections, educators are able to empower students to append new knowledge to previously acquired learning (Piaget, 1979). According to Dewey (1902), children learn naturally what is relevant to them, and this is rarely unconnected facts and details. The current organization and structure of learning experiences in the elementary school classroom is unnatural, and unaligned to how children learn (Lamanauskas, 2010). Lamanauskas (2010) wrote that in the constructivist epistemological approach, learners create knowledge based on pre-existing knowledge, while also connecting new learning to prior experiences. Because of this, learning in the constructivist setting is more meaningful and personal (Dowden, 2007;

Lamanauskas, 2010; Piaget, 1979). Lamanauskas (2010) wrote that the implementation of constructivism in the classroom involved awareness of students' cultural backgrounds, individual personalities, allowances to question and analyze higher-order thinking skills as well as integrated curriculum (p. 7). While constructivism is a philosophy behind instructional practices, content integration is part and parcel to the implementation of constructivist education.

Though content integration can benefit all students, it is especially powerful in teaching high-achieving students. According to VanTassel-Baska et al. (2009), integration's greatest impact can be seen in students with the greatest capacity for learning (p. 30). Dowden (2007) stated that instruction, and curriculum, should be centered on the student rather than the subject. Virtue et al. (2009) offered further support for content integration by stating that students benefit when different subjects are not taught in isolation (p. 5). Following the constructivist concept of centering learning on the child, Lee (2007) wrote that many concepts which may not seem to have an apparent connection in the mind of a teacher are actually connected within the students' concepts of their experiences (p. 160). These connections can be most firmly made by those students identified as high-achieving students (VanTassel-Baska et al., 2009).

Content integrated instruction exploits educational connections within the curriculum to increase student achievement. Youm (2007) reported that integrated learning not only motivates students, but that it also supports higher-level thinking skills. Piaget (1979) wrote that students have a need to connect what they already know to what is being learned. In the real world the application of knowledge must function as a whole, and there are many situations where humans must rely on skills acquired in the content realms of science, math, reading and social studies simultaneously (Lee, 2007). Youatt and Wilcox (2008) wrote that integrated learning prepares students for the future, empowering them to make "informed" and responsible decisions (p.26). Therefore, increasing the overall use of content integration stands to benefit students not only in the area of test scores, but also in adulthood and efficacious citizenship.

Student problem-solving and inquiry-based learning is native to the domain of science instruction (Feng et al., 2004). Integrating science content with other areas of the elementary curriculum allows for math, reading and social studies activities to also partake in problem-solving and inquiry to a greater degree (Youm, 2007). Not only will students be taught according to how they learn (Dewey, 1902; Dowden, 2007; Piaget, 1979) but students will gain the knowledge and skills that they will rely upon in the future (Lawrence, 2007; Furner & Kumar, 2007).

Furner and Kumar (2007) wrote:

> In an era dominated by mathematics, science, and technology, it is essential that science and mathematics be taught in K-12 and that classroom teachers are equipped with the knowledge and skills to teach both science and mathematics meaningfully to students. However, in a test driven curriculum where students and teachers are evaluated on student performance based on reading and mathematics standardized test scores, teaching meaningful science remains a challenge. (p. 185)

But this need not be the case. Carefully planned integrative experiences allow students to have adequate exposure to all learning objectives identified by the state of Georgia (Lawrence, 2007).

Lawrence (2007) supported the practice of incorporating science standards and objective into other lessons and activities, especially by those who do not normally teach science. According to Lawrence, this practice has the potential to make learning more relevant. Putman, Smith, and Cassady (2009) stated that science is well-suited for a curriculum that is integrated. Putman et al. (2009) specifically support reading instruction that supports science standards (p. 320). VanTassel-Baska et al. (2009) conducted a longitudinal quasi-experimental study of reading comprehension in Title I schools. A Title I school is a school which receives additional funding by the U.S. Department of Education because it has been identified as a school attended by a high population of low-income students. In reference to the needs of high-level learners, VanTassel-Baska et al. (2009) cited the value of science to bring “reflective thinking” and “advanced-level” work to other areas of the curriculum (p. 9). Kinniburgh and Busby (2008) found benefits to social studies integration with core subject matter. Because of the potential for science instruction involving inquiry, reflective thinking, and problem-solving (VanTassel-Baska et al., 2009), high-achieving students stand to make significant gains when science is integrated across the curriculum. Integrating science into other areas of the curriculum, not only ensures that it will be taught, but that students will be able to attach new learning to previously acquired skills and knowledge (Dowden, 2007; Lawrence, 2007; Keeley, 2009; VanTassel-Baska et al., 2009; Lee, 2007; Piaget, 1979). Owens (2009) contended that science instruction is maximized when it is integrated into other areas of the curriculum. Owens (2009) wrote: “Students can only learn science when their prior knowledge is considered and integrated into the learning of new concepts” (p. 51). Piaget (1929) found that learning was only possible when students were able to either develop a new concept, or attach new learning to a previously-acquired concept. Content integration allows teachers to use the child’s intellectual ability to make connections in a way that maximizes learning.

Furner and Kumar (2007) stated,

> Educators who help students develop their confidence and ability in mathematics and science would have a positive impact on students’ lives in the long term. Our students’ careers, and ultimately most of their decisions in life, could rest upon how we decide to teach mathematics and the sciences. (p. 188)

A teacher’s content knowledge in the areas of curriculum being integration is paramount to the quality of an integrated lesson. Furner and Kumar (2007) wrote, “The critical role of mathematics in understanding the relationships between scientific concepts especially in the physical sciences cannot be underestimated” (p. 188). From the work of Furner and Kumar, it is evident that students need to have science and math taught to them in an integrated manner. In life, these areas of thought are commonly used together, so it logically follows that we should integrate these subjects in school (Dewey, 1902).

Youm (2007) concluded that integrated curriculum benefits students and teachers, in that it empowers collaborative group work, while also improving linguistic skills. Collaborative learning is supported by the early constructivist philosophy (Bakhtin, 1981; Vygotsky, 1986). Another benefit is the improvement in classroom management. This is attributed to the active engagement of students in their learning activities. Youatt and Wilcox (2008) wrote that integrated learning is more interactive and engaging, rather than the passive education some students are familiar with (p. 26).

Youm (2007) wrote that instruction and pedagogy must change because the demands of education in the twenty-first century have changed (p. 24). Children need to have learning experiences based on real-life occurrences and culture (Youm, 2007). Youatt and Wilcox (2008) stated: "This new signature pedagogy can be characterized as discovery-centered, interdisciplinary, integrative, translational, and contextual" (p.25). Integrating science-based learning objectives into other areas of the elementary curriculum stands to benefit children.

The Contrasting Point of View

Content integration may not be a panacea to the problems facing science instruction. McGlynn (2007), for instance, found that the positive effects of integration in Northern Irish schools in the U.K. were not profound enough to justify the expenditure of resources to implement content integration. According to Furner and Kumar (2007), expecting teachers to integrate without proper training and professional development might do more harm and good. Therefore, prior to encouraging content integration within the suburban Georgia schools, it was prudent to first investigate how we, as educators, currently define and use science content integration. Afterwards, further studies should examine the effectiveness of science content integration, and determine if it is worth the costs of teacher training and support.

In their study regarding teacher preparation programs, Berlin and White (2010) found that though many teachers value the use of science content integration. However, the researchers concluded that while many participants felt that it was beneficial to students, its implementation was too difficult and impractical. According to Berlin and White effectively integrating science content is challenging because teachers "perceive fundamental differences" between the nature of science education and other areas of the curriculum (p. 112). Because of the resources required to train educators how to implement science content integration effectively, it was credible to investigate whether or not this practice is worth the costs (McGlynn, 2007). Prior to research investigating this issue, it was important to understand just how teachers in the suburban Georgia schools currently define and use content integration.

Problems with Defining Science Content Integration

Meyer et al. (2010) wrote that an integrated curriculum allows students to make "explicit connections between subject matter and to provide them opportunities for learning transfer, self-directed learning, and exploration of authentic experiences with the subjects" (p. 156). However, defining integration in the current educational climate is difficult. Furner and Kumar (2007) wrote, "The integration of math and science encompasses a number of considerations, for example, teaching math entirely as a part of science, math as a language and tool for teaching science, or teaching science entirely as a part of math" (p. 187). Identifying a common definition for what content integration is, and how it should be used, has been a challenge for educators and researchers alike (Furner & Kumar, 2007; Stinson et al., 2009; Youm, 2007).

Stinson et al. (2009) conducted a qualitative study in which they presented participants with vignettes of instructional activities. Later, the participants were asked to identify which activities were examples of integrated instruction. The researchers concluded that the participants did not readily agree on what constitutes an integrated instructional practice (Stinson et al., 2009, p. 159). Dorfman (2007) stated that many educators struggle with defining integrated learning because the term is not present in the state standards (p. 54).

Meyer et al. (2010) conducted a qualitative study examining teachers' subjective meanings of integrated instruction. Meyer et al. selected participants from rural, suburban and urban settings with a variety of experiences. Meyer et al.'s (2010) findings coincide with those of Stinson et al. (2009) in that many practitioners may have different ideas as to what constitutes integration.

Meyer et al. (2010) provided some examples of different models. Perhaps it is because of the existence of these models that no standard definition exists for defining integration. Meyer et al. (2010) suggested that teachers wanting to integrate math and science may do any of the following: (a) use math for science calculations, such as in chemistry; (b) teach math skills with science as the backdrop, which includes designing charts and graphs; (c) thematic education; (d) a specific discipline, such as biochemistry or oceanography; (e) projects; (f) an activity where students are taught a math and science objective simultaneously; and/or (g) any place in the curriculum where a single concept shows up in both math and science disciplines (p. 155).

According to Youm (2007), *integration*, *interdisciplinary curriculum*, and *integrated curriculum* have synonymous meanings among some educators. According to Stinson et al. (2009), the definition of integration can differ in many ways, sometimes dependent upon what is being integrated and the method by which integration is being implemented.

However, teachers seeking to integrate the core subjects with science can expect to encounter some barriers. Lee (2007) stated that oftentimes, teachers do not use these instructional practices because they lack the skills and time necessary to plan them effectively. Virtue et al. (2009) stated that some impediments to integration in schools may be due to school culture or material constraints as well (p. 5). They also noted that some teachers are "isolated" from fellow teachers due to organizational structure (p. 8). Integrated teaching without collegial collaboration can be difficult (Marklin & Wood, 2007). Additionally, Dowden (2007) warned teachers against the use of "integration" that is trivial or artificial. Dowden suggested that choosing issues or themes relevant to students and investigating these through different disciplinary lenses.

Impediments to Science Content Integration

Youm (2007) stated that although integration is beneficial, there are impediments in the following forms: (a) funding, (b) training, (c) time, and (d) administrative support. Youm stated that when teachers collaborate to integrate, students are able to benefit from different teachers' styles and areas of expertise. The greatest obstacle to subject integration may, in fact, be teacher knowledge. Furner and Kumar (2007) stated: "Although the research and resources are available to support the integration of math and science, in many classrooms neither of them is actively used. This could be based on the fact that teachers do not know how" (p. 187).

Stinson et al. (2009) wrote that some teachers may not be prepared to integrate content into instruction. It is essential that teachers have content knowledge in all disciplines before curriculum integration can take place (Stinson et al., 2009, p. 153). One of the problems with content integration is that many teachers have "inflated perceptions of their own knowledge" and that this makes it difficult for teachers to effectively integrate (Stinson et al., 2009, p. 160). Additionally, some teachers may not understand different standards and objectives enough to effectively integrate them (Stinson et al., 2009, p. 154). These findings support the development and use of specialists to focus on various aspects of the curriculum and then collaborative efforts to design integrated learning experiences for students.

Current researchers (Fry, 2009; Keeley, 2009; Lawrence, 2007; Lee, 2007; Owens, 2009) suggested that integration specifically benefits gifted students (VanTassel-Baska et al., 2009), as these students have needs that are not generally met in traditional classrooms (Cheng et al., 2008; Mioduser & Betzer, 2008). Additionally, content integration seems to work really well with science. Stinson et al. (2009) wrote that some subjects are easier to integrate than others. According to Stinson et al. (2009),

> Teachers of science may generally be in need of science content knowledge improvement just as teachers of mathematics may be. However, once we ask teachers of science to recognize and understand connections to mathematics and vice versa, we create new knowledge gaps and challenges. (p. 159)

Science and math integration may in fact be the simplest way to get started with the practice of teaching different domains of the curriculum simultaneously (Stinson et al., 2009, p. 153).

Stinson et al. (2009) wrote, "Teachers may be more likely to implement practices they understand and value" (p. 160). While integration may require some innovation and change in approach, Dorfman (2007) writes that many of the difficulties posed by integration can be overcome through the use of technology (p. 57). Technology can allow teachers of multiple disciplines to communicate and collaborate while attempting to discover and use overlapping areas in the standards (Dorfman, 2007). Stinson et al. (2009) wrote, "Teachers may be more likely to implement practices they understand and value" (p. 160). Understanding integration from the practitioners' point of view will help schools design programs targeting the expansion and improvement of integrated practices among educators (Reed, & Groth, 2009; Swan, 2009).

Findings of Related Studies

A variety of studies have examined the use of content integration, constructivism, and/or the use of student-centered inquiry learning. Many of these studies, such as Hinde et al. (2007), Kwi-Ok (2011), Park Rogers (2011), and Brown and Kloser (2009), explored the use and effectiveness of curriculum integration. These studies have informed the purpose and design of the proposed study, and their findings are valuable to the body of knowledge on the subject of science integration in the elementary classroom.

Park Rogers (2011) explored the importance of cooperation and collaboration in the use of an interdisciplinary approach with science in the elementary curriculum. This study was a case-study, with the subject being a specific school and its implementation of an interdisciplinary curriculum. This study examined the use of a community of practice (CoP). Within the framework of the CoP, the teachers collaborate in planning, implementation of lessons, and in reflection (Park Rogers, 2011). In this study, sources of data came mainly from interviews and observations. According to Park Rogers members of the CoP took ownership of the grade-level as a whole, rather than their individual classrooms, and this contributed to the overall successful delivery of the integrated science curriculum. Park Rogers wrote that the teachers that were part of the community of practice did not view professional development as optional. Park Rogers wrote (2011), “For these teachers, professional development was an integral part of their teaching practice” (p. 98). At the conclusion of the study, Park Rogers advised that teacher-prep programs should make note of the findings. Additionally, Park Rogers stated that veteran teachers should employ the use of collaborative practices, if they are to be successful in providing students with a high-quality integrated curriculum.

Hinde, Popp, Dorn, Ekiss, Mater, Smith and Libbee (2007) also examined learning via integrated content. Hinde et al. (2007), whose study was of a quantitative design, focused specifically on Arizona’s GeoLiteracy program. The GeoLiteracy program, designed by the state of Arizona, integrates reading with geography (Hinde, et al., 2007). The numerical findings from the study concluded that the majority of students taking part in the integrated learning program experienced greater performance than students who did not. The participants in this study were students in grades K-8. Namely, one specific gain in the participant population was that the students who took part in the program had greater reading comprehension, as measured through testing, than students that did not. The exception to this finding was in some fourth grade participants, who did not experience a reading comprehension increase due to the program. Though this study did not focus on science, it is applicable to the proposed study in that it displays how integrated a core area (i.e. math and/or reading) with another area can benefit students.

Kwi-Ok (2011) conducted a comparative study of preschool students in England vs. South Korea and their mathematics education. The findings indicated that English students have a more rigorous and structured curriculum, though the Korean students have one that integrates other activities, as well as play, into the school day. At higher levels of schooling (i.e. elementary school and beyond), Korean students outperform English students on international standardized tests (Kwi-Ok, 2011). Kwi-Ok also noted that Korean students participate in more hours of extracurricular activities than students in the U.K., as well as other Asian nations. The study concluded that the targeted focus on nonintegrated instruction in science, at the preschool level, did not contribute to success in future years. Additionally, according to Kwi-Ok, the success of Korean students may be attributed to integrated instruction in mathematics, as well as experiences outside of the school setting.

A study by Brown and Kloser (2009) took an unconventional approach. The participants in this study consisted of 15 high school baseball players. Brown and Kloser examined the effectiveness of a program that integrated physics education with concepts related to baseball. At the end of the 48 month study the researchers found that quantitatively there was no improvement on multiple choice test scores. However, the students were able to effectively articulate physics concepts in interviews, using their own terminology. Brown and Kloser (2009) wrote, "These results call attention to the need to reconstruct our vision of science learning to include a more language sensitive approach to teaching and learning" (p. 875). Though the test scores did not show effectiveness, the interviews concluded that the program was successful in assisting students in their own constructive understanding of concepts in the area of physics (Brown & Kloser, 2009).

Recent studies have explored the connection between science curriculums and student experiences. One such study was Hume and Coll (2010). The study was based in

New Zealand, where national mandates call for an inquiry-based, and problem-based, approach to scientific learning. Hume and Coll (2010) noted in their findings that the topic of study oftentimes overshadowed the use of the scientific method, thus interfering with authentic inquiry (p. 56). This study concluded that mandates do not ensure a benefit, and that the support of leadership and professional development is a necessity in providing students with effective science-based learning experiences.

Bossé and Fogarty (2011) conducted a qualitative study on an existing non-integrated set of curricular standards. By analyzing standards in different areas (i.e. math, science, social studies), 13 distinct learning processes were found that overlapped between sets of standards, and at different grade levels. The researchers concluded that the standards should be redesigned in a way that integrates areas of learning, with the learning organized around a set of processes rather than standards (Bossé & Fogarty, 2011). These findings reveal that instructional approaches that come natural to science, such as guided inquiry, can be applied to other areas of the curriculum to the benefit of students.

Investigations that have examined the interplay between teacher beliefs and practices are relative to the proposed study. A portion of these studies also examined the use of constructivist instructional technique. Uzuntiryaki et al. (2010) conducted a qualitative study centered on two research questions, "(a) What are beliefs of pre-service chemistry teachers about constructivism? (b) How doe pre-service chemistry teachers translate their beliefs into practice?" (p. 406). The study began with eight participants which were given semi-structured interviews. Afterwards, three individuals were selected and became the subject of in-depth case studies. The findings of the study concluded that the participants did not have a strong conceptual understanding of constructivist learning, and that there was little connection between the beliefs and practices of the participating educators (Uzuntiryaki et al., 2010, p. 421). These findings raise awareness of the need to provide educators with professional development and training opportunities focused on the practical application of constructivist-based learning in the classroom.

Furtak and Alonzo (2010) used conclusions from the Trends in International Mathematics and Science Study (TIMSS) Video Study as the basis for a study of 28 third-grade science teachers and the quality of activities they provided to students. The study used the TIMSS framework for an examination of teacher practices during lessons on the scientific concept of buoyancy (Furtak & Alonzo, 2010, p. 425). The two sources of data used in the study came from interviews and observations. Furtak and Alonzo (2010) found that the teachers in the study placed an emphasis on activities in the classroom while neglecting the actual science content intended to be taught. Furtak and Alonzo (2010) wrote, "These results suggest that these teachers are prioritizing activity over understanding, trying to get students involved in doing and liking science almost to the exclusion of more cognitive or content-related goals" (p. 445). Furtak and Alonzo (2010) inferred from their data that the reason for this occurence might lie in a lack of teacher content knowledge (p. 446). While this study reveals that educators are using hands-on learning, collaboration and the support of leadership is needed to guarantee that science instruction is high-quality and relative to the needs of students (Hume & Coll, 2010; Miller, 2010; Park Rogers, 2011).

Peters (2010) conducted a case study on a seventh-grade science teacher. The study analyzed the intersection of beliefs, practices, and lesson planning. The three research questions used by Peters (2010) , as published in the study, were as follows:

> (a) What environment must teacher create to promote student-centered learning when students are only familiar with teacher-centered instruction? (b) How will students react to the student-centered learning during an inquiry-based discussion? And (c) What types of issues must be resolved between teachers and students during a genetics unit that is student-centered? (p. 335)

Peters found that student-centered instruction relied heavily upon the setup of the classroom environment.

According to Peters (2010), teachers making the shift from teacher-centered to student-centered instruction should scaffold carefully, using high support at the beginning and shifting gradually to reliance on students' cooperative learning. Peters (2010) found that student-centered inquiry required the teacher to ration out freedom in the classroom gradually as well so that the amount of independence is relative to the amount of responsibility and ownership of one's own learning (p. 344). Peters (2010) wrote, "From a students' perspective, engaging in student-centered activities can be a daunting task, especially if students have little experience in taking responsibility for their own learning" (p. 344). Peters (2010) concluded that it takes skill and a knowledge base to implement student-centered inquiry, and called on teacher preparatory programs to address this. For current and veteran teachers, this finding extends to professional learning opportunities (Park Rogers, 2011).

Some current studies examine the use of constructivist-based instruction in science and other subject areas. Lee Yuen (2010) conducted a qualitative research study that compared experienced constructivist teachers to new teachers. In this study, Lee Yuen concluded that new teachers were lacking in their skills to design and implement lessons in the constructivist format. However, the findings revealed that new teachers of science had more constructivist practices than teachers of other subjects. Lee Yuen (2010) wrote,

> Constructivism is one of many intellectual practices that can be used in education. Although it is extremely important that we consider other methodologies in teaching, constructivism remains an extremely valuable tool, because it allows teachers and students to develop a comprehensive understanding of science and its real world application. (p. 19)

The findings of Lee Yuen (2010) reveal the natural relationship between constructivism and science education. However, the need for professional development and collaborative practice is also apparent in the findings (Park Rogers, 2011).

Stears (2009) studied the application of constructivist-based science lessons in South Africa. The participants in the study were sixth-grade students (i.e., ages 11 and 12), with the majority from poor backgrounds. The study was a qualitative case study, and it found that students who were given constructivist-based lessons experienced higher participation in their lessons than students typically demonstrate. For a segment of the study, Stears (2009) employed focus group interviews. Stears (2009) wrote,

> A science curriculum informed by social and critical constructivist principles has the potential to facilitate the achievement of outcomes other than science outcomes. It allows for the personal and social needs of learners to be met and this may enable them to function more effectively in broader society. (p. 397)

In the study, Stears made reference to the many social issues South Africa has dealt with in the past, as well as in its current state. From the research, Stears concluded that social and critical constructivist learning experiences can help South Africa's students to master science objectives while at the same time looking for solutions to social problems. The study found that effective constructivist-based science learning engages students, while at the same time empowering them to be effective in other areas both inside and outside the classroom (Stears, 2009).

One of the most notable studies, Miller (2010), exposed the necessity of effective leadership in providing students with highly effective science instruction. Miller, in a case study format, examined two school districts' use of leadership in facilitating science education within NCLB constraints. Both school systems investigated by the study were in regions that were once rural but had, over a course of years, become suburban by rapid development. One school system had approximately 3,000 students, while the other served 5,000. The first system experienced "uniform" test scores while the other's scores were highly varied. In reference to the first system, Miller (2010) wrote,

> One clear example of how this K-12 department supported science teaching in the elementary schools cam in the form of yearly refinement of the K-12 science curriculum's articulation to the state standards by using the state test data, particularly by using the state science test's item analysis, which allowed the

> department to determine areas of the standards that were not being adequately addressed. (p. 25)

Miller (2010) stated that carefully-designed leadership at the system level can ensure high-quality education while simultaneously providing a panacea for existing gaps in teacher content knowledge (p. 29). Miller (2010) concluded that the use of a "professional learning community" (p.29) is essential for effective teaching of science in the age of NCLB and testing.

Though these studies are different from the proposed study, the findings bear importance and relevance to the topic of research. The findings of the recent studies reveal that effective science instruction should be student-centered (Peters, 2010), while embracing the use of inquiry (Hume & Coll, 2010). Additionally, the application of constructivist principles enhances the quality of science instruction (Lee Yuen, 2010; Stears, 2009). The use of integration stands to benefit learners (Bossé & Fogarty, 2011; Hinde et al., 2007). However, the need for the support of leadership (Miller, 2010) and participation in continuous professional development is required (Park Rogers, 2011).

Models of Integration

This study used models of integration as defined by other studies. The sources for these models were Meyer et al. (2010) and Stinson et al. (2009). These two studies were similar in their methodology and sampling, and both supported similar findings. Among these findings were the different models of integration as defined by Meyer et al. and Stinson et al. . Stinson et al. and Meyer et al. identified the following forms of content integration: (a) process integration, where knowledge or a skill in one area is used in another; (b) pedagogical integration, where knowledge or skills in one area of the curriculum are used in another to make an analogy or example; (c) thematic integration, where a central subject or idea is used in all areas of the curriculum; (d) interdiscipline integration, where multiple skills and applications within the same curricular area are used simultaneously; (e) project-based integration, where a goal, task or project unites skills from different curricular areas ; and (f) simultaneity, where skills and knowledge from multiple areas are taught simultaneously, with no dependence upon one another, while given equal importance.

One of the findings of Stinson et al. (2009) was that the type of integration being used was often dependent upon the complexity of the task. For example, when thematic integration was used it was with the practice of being able to adjust difficulty level with facts and details (p. 155). However, the study was focused on whether or not teachers defined a specific scenario as integrated or not integrated. The study found that there was high variance between opinions of participants. Similar findings were published by Meyer et al. (2010). The models of integration, as identified by Stinson et al. and Meyer et al., are used by this study as a starting point. Data analysis, presented in Section 4, was based on these descriptions. Appendix C identifies each type of integration and a description, as identified by Stinson et al. and Meyer et al. .

Methodological Literature Review

Creswell (2003) wrote that case study research is centered upon the exploration of a problem or “issue within a bounded system” (p. 73). Because I wanted to work with a smaller number of participants, so that I could deeply investigate the issue, a collective case study was the best option for this study. Grounded theory or other such qualitative methods would not have been optimal. In grounded theory research, the purpose is to develop or identify a theory after data collection has taken place (Creswell, 2003). I was not attempting to arrive at a theory, but rather a description of what science content integration meant and how it was used in some classrooms.

A phenomenological approach would not have been appropriate because this study was not centered upon a phenomenon but upon a practice (Creswell, 2007). A narrative study would be focused on one individual and his or her experiences with the world (Cresswell, 2007). I was investigating a practice that takes place during the course of employment, not a cultural experience. For that reason, ethnography was not an appropriate model for this study.

Quantitative methods were not suited for the exploration of this issue. Qualitative methodologies must be employed when a researcher needs to explore a problem or how humans perceive an issue (Creswell, 2007). Because a collective case study allowed me to gather deep data concerning a finite issue, within the scope of individual practices in the classroom setting, the collective case study approach was the only suitable option for this study (Creswell, 2007).

Science content integration has the power to maximize instructional time, while ensuring that all objectives are met (Youm, 2007). Additionally, science content integration allows students to learn in a way based on natural inquiry, in a constructivist format (Dewey, 1902; O'Toole, 2010; Piaget, 1979). Because research supports this practice, I proposed to examine how the practice is defined and used at the local level (McGlynn, 2007; Stinson et al., 2009). Section 3 describes the methodology used for this study.

Section 3: Research Method

Introduction

According to information publicly available through the Georgia Department of Education (2011), approximately 20 % of students in a suburban Georgia school's Grades 3-5 did not receive a passing score on the science subtests of the Georgia CRCT. The data showed that students in suburban Georgia schools exceeded the state average. But nevertheless there was an overall need to increase achievement in science statewide.

This study investigated definitions teachers individually attribute to the term *integration* as it applies to the elementary science curriculum. Additionally, this study examined how teachers implement science content integration and what they view as impediments to integrating science content with other areas of the curriculum. Because this study dealt with the meanings humans attribute to a concept, a quantitative approach was not appropriate for this study (Creswell, 2007). A quantitative study would limit responses of participants to test data or survey instrument responses. Because content integration can be used in so many different ways, it is important for participants to state in their own words what meaning it has for them. At the time the study was proposed, It was unknown how the practice of content integration is defined and utilized in suburban Georgia schools.

A local definition for integration was established to facilitate teacher support and development in science instruction. An exploration of participating educators' current practices was a relevant source of data that could contribute eliciting positive changes in education (Brodie & Thompson, 2009). In their research on implementing content integration, Berlin and White (2010) gathered data on how teachers used what they had learned in a training program. Their findings provided data on how the program should be improved for future attendees. This same concept was applied to this study.

In seeking to understand the participants' experiences and development as science educators, I interviewed teachers to study their perspectives. Other sources of data included audio recordings of lessons, as well as lesson plans. These data collection methods are consistent with Creswell (2007), who acknowledged qualitative methodology when interpretation is needed. Creswell (2007) wrote, "We conduct qualitative research because a problem or issue needs to be explored" (p. 39).

Research Design

According to Creswell (2007), it is appropriate to use a qualitative approach when a quantitative study does not "fit the problem" (p. 40). Additionally, a qualitative approach is used when the researcher wants to understand the issue "in context" to the setting and participants (p. 51). This study was best conducted using a qualitative methodology. While quantitative analysis would be useful in determining the degree of effectiveness of the practice of integration, information is first needed regarding how elementary educators ascribe meaning to content integration. As suggested by Creswell (2003), this investigatin required a qualitative approach. Creswell (2007) wrote that the proper time to use a qualitative approach is when a "problem or issue needs to be explored" (p. 39).

Before it could be determined whether or not science content integration was effective, I sought to explore how teachers defined and used it. Rather than limiting the definitions to a few choices on a survey instrument, interviewed participants and allowed them to explain, in their own language, their thoughts on the subject. Perhaps later ies studcould analyze the impact, on test scores, of a specific defined implementation of integration. Studies of this nature could inform educational leaders, and school board members of the costs and benefits of professional development programs supporting the integration of science content.

The qualitative approach used for this research was the collective case study. My primary focus was to explore how teachers define science content integration, and whether or not integration is used in their instruction. Qualitative research allowed this topic to be fully explored from the human perspective, while a quantitative approach would have been ineffective. Creswell (2007) wrote, “The logic that the qualitative researcher follows is inductive, from the ground up, rather than handed down entirely from a theory or from the perspectives of the inquirer” (p. 19).

Qualitative inquiry is constantly undergoing changes and developments (Creswell, 2007). However, one constant is that qualitative study places the researcher in the field in the natural setting (Creswell, 2007). In contrast to quantitative methods, qualitative research requires the researcher to interact with participants personally, to gather comments and insight into the human experience (Creswell, 2007, p. 37).

According to Creswell (2007), prior to a study, a stance should be taken that will guide the study and findings (p. 19). This stance may be postpositivist, social-constructivist, advocacy, or pragmatist (p. 20). Creswell wrote that this worldview or assumption is important because it deals with how participants and researchers approach world societal issues (p. 370). This study embraced Hatch’s (2002) description of the constructivist paradigm.

Hatch (2002) indicated that the constructivist stance fits best with qualitative case studies. Hatch wrote, “Knowledge produced within the constructivist paradigm is often presented in the form of case studies or right narratives that describe the interpretations constructed as part of the research process” (p. 15). This is due to the fact that within a constructivist research paradigm, the core tenet is that humans construct their own knowledge on an individual basis (Hatch, 2002, p. 13). Additionally, as people construct their own knowledge, they are in fact constructing their own realities based upon their individual experiences. Therefore, multiple realities may exist, according to the constructivist stance (Hatch, 2002, p. 13).

Phenomenology is one type of qualitative design that seeks to obtain the view of multiple participants on a common phenomenon (Creswell, 2007). These studies are focused on the phenomenon itself rather than on the participants (Creswell, 2007). Phenomenology attempts to find commonalities among the experiences of the participants in order to describe a phenomenon. While this approach might be beneficial to the present study, I sought to explore teachers’ experiences in greater detail, not separated from the phenomenon of content integration.

Narrative studies seek to understand the lives of individual persons and their experiences. Creswell (2007) wrote that these studies are limited to one or two individuals. They are concerned with the participants themselves rather than with a phenomenon. A narrative study seeks to “explore the meaning of experiences” (p. 54). A narrative study was not appropriate for this research because it limits the number of participants. For this study, I sought more than one or two viewpoints.

Creswell (2007) wrote, “The intent of a grounded theory study is to move beyond description and to generate or discover a theory” (p. 62). The basis of grounded theory research is that a theory is somehow grounded in the data, and emerges through coding and analysis (Creswell, 2007). While this approach could definitely be used to explore effective instruction, the goal of the present study is not to develop a theory but rather to collect experiences of educators. Thus, a grounded theory approach was discarded.

Ethnography design is another type of qualitative study that attempts to study a culture in-depth. According to Creswell (2007), a culture is the “shared patterns of behavior, beliefs and language” (p. 68). Because the goal of this study was not to study a culture, ethnography was not the best choice. However, in ethnography the researcher is subjected to the natural setting and embedded with the participants (Creswell, 2007). Therefore, while an ethnographic approach is not appropriate for the study, the use of a similar technique would shed light on effective integrated science instruction.

While the number of participants in an ethnography was limited to less than 20 participants (Creswell, 2007), the number of participants in a case study is even less. In a case study, “an issue” is investigated rather than a culture. The chief form of data in a case study is the interview. Creswell (2007) wrote, “Case study research involves the study of an issue explored through one or more cases within a bounded system” (p. 73). In a case study, which requires intentional purposeful sampling, a researcher can show multiple perspectives on an issue (Creswell, 2007).

Research Questions

There were three research questions for this study. First, how do teachers individually define science integration? Second, how do teachers use science integration in their classrooms? Last, what do teachers perceive as impediments to content integration?

Context of the Study

This study was centered on the use of science content integration in elementary schools in suburban Georgia. Despite the state's ranking of 16th in the nation with regard to teacher pay, Iosova (2010) reported that Georgia's attrition rate for teachers is higher than many other states. According to Owens (2009) and Lawrence (2007), teaching science can be difficult for teachers due to many factors. Gardner (2010) wrote that when teachers are frustrated or feel overwhelmed, they often leave their current teaching assignment to find employment elsewhere. The attrition rate is a financial burden for the state of Georgia (Gardner, 2010; Iosova, 2010).

Knowing how teachers define and use integration in suburban Georgia furnished a starting point for future research. This future research should target exploring the effectiveness of content integration in local schools. Because a high population resides in Georgia's suburban areas, understanding the definition and use of content integration was a critical local issue.

Measures for Ethical Protection of Participants

According to Hatch (2002), researchers should fully disclose their participants the parameters of their participation in a research study. Hatch warned against research that takes place where the participants do not know that they are participants, and stated that this is unethical. Therefore, it is ethical to inform the participants about how data will be collected, why they were asked to participate in the study, and how the data will be used.

For this study, participants were intentionally selected via personal contact. All participants were educators in a single suburban Georgia elementary school, and practitioners of science content integration. A group of five participants were selected using the criteria of the type of students they taught, as well as years of experience.

The participants selected represented a variance of experience levels. At least one of the participants had over 10 years of experience educating children, and at least one other was in their first 5 years of teaching. Using the above criteria of participant selection allowed the number of participants to remain within the limitations suggested by Creswell (2007), while still allowing for a variety of perspectives.

Participants were asked to provide signed consent to participate in the study. The consent form clearly stated that participation in the study is strictly voluntary and that participants may withdraw from the study at any time, with or without cause. All information provided by the participants is kept confidential and pseudonyms were utilized in reporting findings rather than the real names of the participants.

Transcripts from the interviews were kept in such a way that the identity of the participant would not be discernible from the data. During transcription of interviews and in data reported throughout this study pseudonyms were used in lieu of actual names. All interview audio recordings are kept under lock and key as a further protection. There are no known risks associated with this type of research and participants were not coerced in any way, or threatened in such a way as to elicit participation. No data were collected for this study until it received approval from the Walden University Institutional Review Board. The approval number for the study was 01-06-12-0113021.

Role of the Researcher

From my personal experiences I have witnessed my colleagues discussing leaving the profession due to increasing burdens, as well as a lack of instructional time. As an educator certified to teach science in all grade levels in the state of Georgia (i.e., kindergarten through Grade 12), I have perceived others simply not teaching science due to NCLB-associated goals and time constraints. In my previous teaching assignment, I used content integration to fulfill my duties.

Like the participants, I am a fellow educator in the elementary school where the participants are employed. I am a colleague of the participants, rather than a supervisor. I functioned as a data-collector and data-interpreter. I performed the data analysis personally; however, I asked the participants to assist in establishing validity through the member checking process. My roles as researcher and as a fellow educator did not jeopardize the credibility of the findings. I am not in a position of authority over the participants. In addition, the participants' identities were kept confidential, and participants' real names were never used.

I was inspired to research this topic because of my current employment in the position of science specialist and instructional coach. I have personally witnessed the lack of instructional attention given to science, and I find it troubling. While I might not agree with the current law (i.e., NCLB), I understand that schools must carry out the task of meeting AYP with respect to math and reading. I do not believe that we must sacrifice attention in one area of the curriculum, however, in order to give attention and instructional time to another. I have personally used integration in my teaching practices to achieve many objectives with my students. I feel very passionate about this practice and I explored, in a formal study, how it is conducted, defined and used by others. It is my sincere hope that this work will provide insight into how this might be used by educators to the benefit of all students.

I have a strong personal bias concerning NCLB, as well as what I consider an overreliance on multiple choice tests. I also refer to myself as an advocate for science education. According to Creswell (2007) and Hatch (2002), admitting personal biases prior to a study is a critical part of qualitative research. My goal in this study was to make a positive contribution to science education. I conducted this study to explore a practice, and to discover the meaning given by fellow educators, to science content integration. For this study, I bracketed my biases by avoiding asking any questions regarding the practice of testing students on multiple-choice tests, as well as NCLB. Should an interviewee have commented on these subjects, I would have acknowledged my biases again in reporting and presenting findings.

Criteria for Participant Selection

For this study, participants were selected on the basis that they are elementary school teachers in a suburban Georgia school system, who also claim to be practitioners of science content integration. Participation was on a voluntary basis, and participation is open to both general education teachers as well as specialists. Creswell (2007) stated that when conducting a case study, researchers should use selective, intentional, purposeful sampling. As such, for this study, an effort was made to select participants from different backgrounds so that multiple perspectives can be drawn into the final data analysis. Though this participant selection method did not allow for as many viewpoints as a phenomenology, the data collection was much more extensive than studies with more participants and points of view. Therefore the number of participants was balanced with a deeper data collection and analysis procedure.

Data Collection

Data collection in a qualitative study is recurring, iterative, and cyclical (Creswell, 2007). There is no linear path that is followed as in quantitative research. Creswell advocated the use of the following multiple forms of data in a qualitative stud, such as: (a) observations, (b) interviews, (c) documents, and (d) audiovisual materials. In a qualitative study, one source of data may be relied upon more than others (Creswell, 2007; Hatch, 2002), for this study, that source was interviews.

During this study, I held interviews with five participants. Selecting five participants is still within the suggested limits of Creswell (2007) and allowed for a good balance between multiple perspectives and depth of data. There were two interviews held with each participant. Each interview lasted approximately 45 minutes in length, so as to avoid fatiguing the participants. I had to hold an additional interview with Mel in order to gain more data. Afterwards, because data had reached saturation, I was not required to hold follow-up interviews. Creswell (2007) defined saturation as follows: "Using the constant comparative approach, the researcher attempt to 'saturate' the categories-to look for instances that represent the category and to continue looking (and interviewing) until the new information obtained does not further provide insight into the category" (p. 160).

The interviews were semi-structured, following the open-ended questions presented in Appendix A. During the interview process, I was sometimes led by an interviewee to a relevant issue pertaining to my research questions that may stray slightly from the questions indicated on the interview protocol. This is common during the interview process in qualitative studies (Janesick, 2004). Though there are different interview styles used in research (Creswell, 2007), the style used for this study was the one-on-one interview. This is most appropriate to a collective case study (Creswell, 2007).

All interviews were digitally recorded, and the files were stored on a computer. As an additional precaution to prevent the loss or corruption of the files, the audio files were also stored on a disc which and placed in locked storage. During the interview process, I made notes which would consist of ideas for preliminary codes in the margins of my physical notes, which I required during actual coding and data analysis. Within 2 days of each interview, I transcribed the audio file. Because of the emergent nature of qualitative research, follow up interviews involved questions derived from the transcription of a preliminary interview (Rubin & Rubin, 2005). Coding began directly after the transcription of interviews.

Two secondary forms of data were used for this study: (a) documents in the form of teacher lesson plans, and (b) audio material in the form of a recording of a teacher-led activity or lesson. During the audio recording, the focus was on the teachers rather than the students. It was the actions and words of the teachers that were analyzed, while any actions or behaviors of students are neglected as a source of data in this study. The lesson plans were photocopied and then coded. The coding process for all sources of data was similar in that the codes would relate directly to the original research questions. According to Hubbard and Power (1999), it is best to preserve originals because the very act of coding might alter raw data. After the documents are photocopied, they were digitally scanned and the images stored on a computer hard drive, as well as on disc in a similar manner to the interview audio files. The audio was stored on a computer hard drive, as well as multiple DVD's, and stored with other data. The discs were also kept under lock and key to protect confidentiality and prevent corruption or loss.

The protocols for data collection and analysis of audio recordings and lesson plans are provided in Appendices B and C. Coding took place, just as in the interviews, and multiple copies of the same protocol might need to be used for the same lesson plan or audio recording of a lesson. Notes were made in the margins and headers as needed (Creswell, 2007; Hatch, 2002; Rubin & Rubin, 2005). This might provide assistance during future interviews or data analysis.

The rubric contained in Appendix B was developed from Stinson et al. (2009), while the rubric in Appendix C is based on Meyer et al. (2010). Both of these studies were similar in their design, and were conducted by some of the same researchers. The studies explored various manifestations of content integration, and employed teachers as participants. Both studies concluded that teachers did not agree on whether or not various examples of instruction were integrated.

Utilizing these multiple forms of data lends credibility to the study. The multiple data sources (i.e. interview transcripts, audio recordings, and lesson plans) allowed me to triangulate the codes that emerge from the data. Because of the nature of qualitative research, data analysis and data collection was concurrent, and recurrent (Creswell, 2007). I followed the suggestions of Hubbard and Power (1999) in keeping my data collection and analysis constantly focused on my research questions. A required part of data collection is ethical consideration for participants (Hatch, 2002). During the course of this study the confidentiality of participants was upheld. If at any time a participant wished to be excused from the study, he or she was permitted to withdraw. This held true even after data collection had concluded.

Data Analysis

Creswell (2007) explained, “During the data analysis the researcher follows a path of analyzing the data to develop an increasingly detailed knowledge of the topic being studied” (p. 19). During data analysis, I maintained focus on the research questions (Creswell, 2007; Hatch, 2002; Hubbard & Power, 1999). This was because the nature of qualitative data is that participants might provide data not directly related to the research goals.

Data collection and analysis were conducted concurrently in this study, promptly followed by transcription (Creswell, 2007; Hubbard & Power, 1999). Using the transcripts, I began the search for relevant codes that provided insights into the research questions. This is the process that Creswell (2007) referred to as “lean coding” (p. 41).

The next phase in the process was to take the voluminous collection of codes and combine those that are similar (Rubin & Rubin, 2005). Some, after further inspection needed to be deleted (Creswell, 2007; Rubin & Rubin, 2005). This could only be done after the data collection is concluded. Data collection continued, until the data that targeted the research questions were saturated. According to Creswell (2007), saturation occurs when the data ceases to provide further insight into categories or themes of data. During this phase themes emerged from the codes that I noticed in the data. This time-consuming process was done with NVivo 9 computer software. The software program was used to categorize, organize, and retrieve data tagged by a specific code that I assigned.

Even with the assistance of computer software, I expected the data analysis phases to be time consuming. One of the most difficult processes was establishing themes from the data. This was a classification process that involved placing codes into various categories. This process was best explained by Creswell (2007) who stated, "Moving beyond coding, classifying pertains to taking the text or qualitative information apart, and looking for categories, themes or dimensions of information" (p. 153).

Creswell (2007) asserted that the use of *a priori* codes is a controversial subject in qualitative research (p. 152). I refrained from the use of *a priori* codes, and only applied codes that revealed themselves within the transcripts, audio recordings or lesson plans. I could not predict these codes. I only became aware of the codes once data collection and analysis began. Also, different sources of data revealed different codes, which I kept separate until triangulation.

The final phase of data analysis began when I interpreted and presented my findings. Creswell (2007) described this process as a type of induction. I searched through my field notes, as well as the raw data itself once again. I followed the directions of Creswell in starting with a large body of raw data, coding the data, reducing codes into themes, and finally making generalizations from the themes. It was at this point that I took my findings back to the participants, so that they could participate in the member-checking process (Creswell, 2007). Triangulation and member checking were the strategies I use for establishing credibility of my findings.

Trustworthiness and Credibility

According to Creswell (2007), there are many perspectives and viewpoints on how to measure the trustworthiness and credibility of qualitative studies (p. 207). In this study, the two main processes that were used were triangulation and member-checking. Relying on more than one type of validation strategy ensured that the findings portrayed an accurate understanding of the viewpoints of the participants (Creswell, 2007). Creswell (2007) stated that triangulation “involves corroborating evidence from different sources to shed light on a theme or perspective” (p. 208). The member-checking process involved presenting my findings to each participant. I asked for their comments on my data analysis and conclusions. If any participant did not feel that the findings are credible, then I would report that as part of my conclusion and further collect and/or analyze more data.

For this study, the sources of data were interviews and their respective transcripts, documentation in the form of lesson plans, as well as audio recordings of lessons and activities. The Appendices contain the criteria for how these sources of data were analyzed. Triangulation was used to compare and contrast the codes I identify in each of the sources of data. Each set of codes was compared to the two others (e.g., interview codes compared to codes established from the audio recordings and codes established from lesson plan review). Additionally, my personal field notes were used during this process to contribute to triangulating credibility.

Member-checking was also be used as a validation process in this study. According to Creswell (2007), this “involves taking data, analysis, interpretations, and conclusions back to the participants so that they can judge the accuracy and credibility of the account” (p. 208). Participants were informed of this process prior to the study, so that they knew what was required of their participation. Participants were asked to meet with me, so that I could present my conclusions, codes and themes to them. I asked them for to examine the data and to provide their own conclusions, as well as opinions regarding my conclusions. The study was not finalized until the participants and I had a consensus on the findings. I would reexamine and reanalyze the data until this occurred.

Creswell (2007) wrote, “Reliability can be enhanced if the researcher obtains detailed field notes by employing a good-quality tape for recording and transcribing” (p. 209). For this study, all data was stored digitally on a computer hard drive and as data files on DVD’s. All interviews were transcribed, though the transcriptions used pseudonyms of the participants rather than their actual names. Careful record-keeping and accurate notes will serve as a third process of validity in this study (Creswell, 2007). Recorded audio of the interviews was kept under lock and key in case it is needed after transcription for further verification. Section 4 describes the results of the study, while Section 5 follows with conclusions and implications of the findings.

Section 4: Results

Introduction

The three questions for this study were the following: (a) How do teachers individually define science integration? (b) How do teachers use science content integration in their classrooms? and (c) What to teachers perceive as impediments to science content integration? The purpose of this study was to explore the research questions in an effort to gain a greater understanding of the subject of science content integration.

I collected data over the course of three months. After interviews were conducted, audio recordings were transcribed as quickly as possible. A similar process was used with the recordings of lessons and activities. All audio was recorded digitally, and then stored on a computer hard drive, prior to transcribing. The latter transcriptions and audio recordings were then stored on a DVD to preserve and store the data. These data are currently held in a locked steel cabinet, to prevent loss by theft/burglary or destruction by fire.

The following sections dicuss the characteristics of the participants, and the process of data collection. A discussion of the data sources and the coding process follows. Next, there are sections on the findings of the data analysis and the emergent themes. Finally, Section 4 is concluded with a discussion of the evidence of quality in the study.

Participant Characteristics

Five teachers participated in this study. To ensure confidentiality, pseudonyms are used in place of their real names throughout this study. The cases for this study were the practices of the educators, rather than the educators themselves. However, the way in which the educators practice their craft is highly influenced by the background of the individuals. Therefore, a short personal description of the personal characteristics of each participant is relevant to the findings of the study.

Rachel

Rachel was a first-grade teacher with over 15 years of experience in elementary education. Rachel proclaimed to be from the "old school" of teacher training and development. Her comments emphasized this on many occasions. Rachel has spent most of her career teaching first-grade, spending only 1 year teaching fifth grade. Rachel primarily used thematic integration. She also planned themes for other teachers on her grade level.

Stephanie

Stephanie taught a self-contained special education class. She has been teaching for over 30 years. Stephanie taught seven students who ranged in enrollment among Grades 3-5. These students have different needs and characteristics. According to her comments, Stephanie often had to tailor materials to suit these needs, as currently available materials are unsuitable for her students and their needs. Stephanie asserted that her use of integration is to reinforce skills and concepts, rather than to attain skills and concepts.

Max

Max was a third-grade teacher who is relatively new to the profession. At the time of the interview, he was in his sixth year of teaching. This was Max's second year teaching third grade students. His first 4 years were spent as a kindergarten teacher. Max recently earned his Master's degree and became endorsed to work with gifted and advanced students. Therefore, many of his lessons must go further into depth with science learning objectives. Max's perspective might have been based in part on his point of view as a former kindergarten teacher.

Brenda

Brenda was a veteran teacher who stated that she is 5 years away from retirement. Brenda not only teaches second grade but has previously taught fourth grade. Her perspective came not only from her daily experience in the classroom but also from the piloting of materials presented by publishing companies as well as her role as coordinator for the school science fairs. She had many contacts in the communities that she has worked with in arranging demonstrations and presentations in the past. These contacts include representatives from businesses, organizations and colleges. Brenda stated that she liked to focus on hands-on learning activities as the staple for her students' science learning.

Mel

Mel was a fifth grade teacher, who has been teaching less than 7 years. With the exception of teacher training in college, he has never worked with students younger than 9 years of age. Mel's use of integration focused more on the use of science content as a tool to get students excited about other areas of the curriculum. Mel stated that testing was an ever-present concern for him, as fifth grade students are required to pass several areas of the Georgia CRCT as well as a system-mandated writing test. Students in Mel's classroom equated science learning to high-interest experiences. He felt that these experiences provide excitement, and through integration can motivate students for all areas of the curriculum. He felt that this was an exciting topic that students care about and so could capitalize on science and integrate it for purposes of test preparation. Mel's primary form of integration was process integration (Meyer, et al., 2010).

Systems Used for Data Collection

Data gathered from the participants provided a broad exposure of science content integration. Collecting and organizing the data required systems and specific procedures. All audio recordings were digitally recorded. All data were organized and given special codes to identify the source and content of the data. The coding system for this process was stored on a password-protected computer along with the files themselves. For the entirety of the study, confidentiality was given the utmost importance. Lesson plans were recorded on the lesson plan located in the appendix.

After the audio recordings were transcribed, they were given a special code to connect the various data connected to each participant, but which would still prevent the identification of that participant by an outside source. The purpose of this was to allow the researcher to know the population of students each participant worked with, while protecting their confidentiality. All audio files have been placed on DVD, and along with transcripts are stored in a steel locked cabinet where they will remain for seven years.

After the recording and transcriptions, NVivo9 computer software was used to analyze the written documents and identifying codes. At first, 43 codes were identified from the volume of data. Later, through connected recurring and similar codes, these were reduced to 23. The data were reexamined and a new phase in the coding process condensed, through merging similar codes, the 23 codes into ten, which are presented in Appendix E, along with the frequency of their recurrence. These condensed codes were all related to the research question, and provided direction to arriving at sound findings and conclusions. Finally, the 10 condensed codes were used to establish the six themes which constitute the findings of the study. The themes that later emerged revealed the heart of the data, and then these were presented to each participant, individually, for their commentary which constituted the member-checking process.

Once all data were gathered, they were analyzed using NVivo 9 computer software. Words from transcripts were entered into the software program and then I personally coded the data. The software program was used primarily for storing and organizing the codes. The program was also used to recode data, afterwards. This was the condensed coding process. The codes that were relative to the research questions are presented in Appendix E. These codes were then later reanalyzed and condensed further into the themes. The themes were the answers to the research questions as indicated by the participants in this study.

The participants confirmed their contributions to the findings, during the member-checking procedure. Although some were fascinated by the themes, they commented that the findings tended to resonate with what they understood about their profession, peers, and so forth. Each step of coding was a lengthy process involving hours of reading and review. The use of the software in searching for key terms did assist, although there was much rereading and review involved. There were several codes that only pertained to a single instance, and so where left out of future coding phases.

The omitted codes usually appeared one or two times. These codes usually applied to only a few data instances; the most prevalent ones are identified in Table 1. Due to the nature of the study, where an attempt was made to ascribe meaning to a topic,

Table 1 shows various codes and trends that emerged during the research but are not directly related to the research question. They are included here because they elaborate on a bigger picture on the subject of science education as a whole, on which science content integration depends. Because these codes did not apply to the study's research questions, they were used as a data source for condensed coding, or for the establishment of themes.

Table 1

Data Unrelated to Research Questions

Participant	Data
Brenda	Hands-on learning as science instruction.
Max	Teacher preparation and administration.
	Higher-level science learning.
Mel	Pressures of test preparation.
Rachel	Thematic learning and the pedagogical understanding of first-grade students.
Stephanie	Differentiation of learning, according to student need.

Another system that was part of this study were the methods for establishing quality. During the member-checking process, participants met with me to discuss the findings. I explained the methodology for the study, including how and why sources of data were chosen. Later, I presented the broad codes, explaining how some were deleted, others were combined and still others were placed in the discrepant data category. I explained the research questions and the data presented by the participants as a whole that led to the establishment of themes. The participants agreed with the themes, though Rachel and Stephanie commented that they were enlightened by the findings. Rachel commented that she had used thematic teaching in the upper grades and was previously unaware that it wasn't a more common practice. She also commented that being a first grade teacher and thus removed from standardized testing in her system (where Grades 3-5 take these tests) she could easily see how the data from participants might differ.

Stephanie felt somewhat removed from the practices of other teachers. As far as her position in the school is concerned, there are only two other individuals in the school who teach students with profound special needs. Therefore, instructing students in the attainment of functional life skills was not a focus or concern for other participants. She stated that she was often "left in the dark" with respect to the practices of other teachers and was therefore not surprised by the findings. In summary, no participant disagreed with the findings or found fault with the methodology. Systems used during the study allowed for the collection of data, as well as analysis and providing evidence of quality.

Interviews

During this study, interviews were conducted on a one-on-one basis. Prior to the interview session, I asked for any questions and/or concerns. Once the interviewee stated that he or she was ready, I started the recording device and began to ask questions as shown in the interview protocol (Appendix A). The interview protocol was used as a guide to the interview process rather than a script. The questions deviated from the actual wording of the protocol, as befitted the situation. Many follow-up questions were also used, dependent upon where the interviewee took the interview sessions, while still remaining in the confines of the research questions. The actual duration of each interview session varied, with some lasting just over 30 minutes and others lasting for 1 hour.

During the interview process, carefully orchestrated questions in such a way to bring the conversation back on track after it had strayed. On many occasions, I had to alter the wording of questions in the interview protocol to engage the participant in conversation. Sometimes it was also necessary to restate or reword a question in order to elicit more of a response. As such, some of the data gathered did not apply to the research questions. However, through the use of follow-up questions I was able to reach a saturation of data. Data gathered through interviews was the primary source of data in this study. However, other data sources were required in order to gain full exposure of subjects perceptions of the problem. The use of audio recorded lessons allowed me to collect data on how teachers actually practiced science content integration.

Audio Recorded Lessons

Participants were asked to record, with audio, two lessons or activities that they conducted in their classroom. The words of the teacher were then transcribed by me and analyzed via the Audio Observation Document (Appendix B). During the analysis process, I examined the transcripts of audio to locate identifiers for the type of integration being used in the classroom.

Audio Recorded Lessons were analyzed according to the Audio Observation Document which is contained in Appendix B. This document was created based upon the findings of Stinson et al. (2009) and Meyer et al. (2010). When teachers integrate, they will integrate content, processes and/or skills (Stinson et al., 2009; Meyer et al., 2010). Additionally, a construct is needed for integration, and this may be a theme, a project, or some other instructional technique (Stinson et al., 2009; and Meyer et al., 2010). Lastly, part of analyzing an integrated activity is to investigate the level of dominance of one subject over another (Stinson et al., 2009; Meyer et al., 2010). True equivalence in an integrated lesson or activity almost never occurs (Stinson et al., 2009; Meyer et al., 2010).

The recorded lessons reflected on different areas of science learning and the curriculum. Data gathered from audio of lessons led to findings related to the first two research questions, which concerned the definition and use of science content integration. Some lessons were not “science lessons” but rather language arts lessons that included science standards and objectives. A portion of analyzing integrated lessons is in investigating and identifying the dominance of one subject over another (Meyer et al., 2010).

After the audio lessons were recorded by the teacher participants, I analyzed them according to the Audio Observation Document. This process was followed by a further coding analysis using text with NVivo 9 computer software. The first analysis of audio lessons reveals that the participants differed on what they integrated, and what they used as a construct for integration. The level of integration, for all lessons, was either dominance or partial dominance. A description of each of the participant’s lessons is provided below.

Brenda

Brenda’s first lesson involved motion and friction. Students used objects to observe how they rolled and moved on various surfaces. This activity was followed by a teacher-led discussion on Newton’s Laws of Motion. Afterwards, students were to write their observations in a science journal. The lesson was science-dominant with the construct of integration being the scientific observations and explorations. The scientific process of integration was integrated with writing skills.

The second lesson Brenda recorded was similar to the first. This lesson also involved forces and motion, but balls were used rather than a variety of materials. The balls were of several different types, and with this activity, students explored how mass affected motion. The teacher linked this lesson to the one described above with discussions. Again, students conducted their hands-on observations and recorded their findings in science journals. Similar dominance, process integration and constructs were used.

Max

Max's first recorded lesson used magnets as a hands-on exploration. Students were directed to complete some exploration of the magnets and to then share their findings. At the conclusion of the activity, students were to create a poem or song related to magnets. The poem was the construct, whereas the process of creative writing was integrated into the magnetic exploration. The dominance of this activity belonged to science, though the subject of applied creativity (which is specific to gifted students educational objectives) was a close second.

Max's second recorded lesson also involved magnetism. For this lesson, however, students were in different groups and centers. At one center, he led students in a higher level observation activity. Students were given objects, as well as books. Students had to read, while demonstrating processes described in the books. Students had to then record observations regarding compass behavior and magnetic fields in their science journals in the form of illustrations and writing. Knowledge of magnets was partially dominant over areas of learning, while the process of literacy was integrated into the science activity. The construct for the integration of this and the preceding activity was the observation process.

Mel

Mel's first recorded lesson was a demonstration of static electricity using physical objects and a website with animations. Students then conducted a writing activity to communicate findings. Prior to the writing activity, the teacher explained good writing habits and the expectations for the writing sample. Though writing was a part of this integrated lesson, the lesson was very science-dominant. The use of writing was only to communicate the findings of science. This lesson integrated the process of writing into the attainment of science skills and knowledge. The construct for integration in this lesson was an experiment that the students conducted under teacher supervision and guidance.

The second lesson Mel recorded was an examination of nutrition labels. Students read and analyzed several different labels from actual food items. Students then constructed bar graphs, under teacher guidance, to show the relationship to calories to fat grams. This activity integrated reading, math and science. The process of graph construction was integrated across subjects with student data analysis skills being the construct for integration. The dominance of this lesson was partial, with science knowledge given the most attention, and applied through reading and math skills.

Rachel

Rachel's first recorded lesson was related to the theme of shadows. Students first read a high-interest text that was fiction, with blending of science fact. During the reading, she made many references to Groundhog Day, which the students were currently learning about as related to their curriculum. After the reading, the teacher discussed light and shadow. The students then went outside with their teacher to the parking lot where they used colored chalk to take turns tracing their shadows. The construct for this lesson was the theme of shadows. The process of reading, along with the hands-on component was integrated into physics knowledge pertaining to shadows. The theme was a science-based theme and therefore the lesson was science dominant.

Rachel's second recorded lesson that took place during her language arts period. Unlike the other lessons examined during data collection, this lesson was language arts dominant. The lesson consisted of students exploring and brainstorming words with the "-ight" ending. Following this the teacher read a book aloud that was a fiction book, which also involved light, which was the students' current science objective. After reading and discussing the book, students then were given the opportunity to brainstorm different sources of light. This was followed by a teacher-directed class discussion. The construct for integration was the theme of light and shadows, with the knowledge of physics (light) being integrated into the brainstorming writing activity.

Stephanie

Stephanie's first recorded lesson was based on simple machines, which is a physics objective in Georgia for fourth grade students. This lesson integrated reading with science. Students were using nonfiction texts during their reading practices, and also discussing images of simple machines on a visual display. The teacher related simple machines to students' everyday experiences at home and in their daily lives. This lesson was science dominant, but only partially. The teacher interjected many reading strategies and suggestions to her students. Reading skills, and the process of reading, was integrated into science learning, with the construct of integration begin the students' comprehension of the text.

The second lesson recorded by Stephanie was based on biology. Students were to read texts and then construct diagrams of plant and animal cells. To begin this lesson, the teacher had students discuss the differences of living and nonliving things. Students then read text while the teacher supported student understanding with references to their daily experiences, such as that living things need energy, so they either eat or produce food through photosynthesis or chemosynthesis. At the end of the activity, students began their construction of diagrams. The construct for integration was the comprehension of the text. Reading as a process was integrated into science learning. The balance of this activity was a partial dominance of science.

While the use of audio recorded lessons did not shed any light on what participants perceived to be impediments to science content integration, this data source revealed how teachers actually used content integration. A similar source of data were teacher lesson plans. Lesson plans revealed how participants intended to use science content integration in future practices.

Lesson Plans

Teachers were asked to submit two sets of lesson plans, which were analyzed by me using the Lesson Plan Review Document (Appendix C). The use of this form of data allowed the researcher to analyze the frequency of each type of integration that teachers had planned on using in the classroom. These data applied to the first two research questions, but not the third, which referred to teachers' perceptions regarding impediments to integration.

The data revealed that about half of the science lessons featured integrated content. Of the integration models used, most were Process Integration, while others were

Thematic and/or Pedagogical (Meyer et al., 2010). In some lessons, more than one type of integration was utilized, as described by Stinson et al. (2009). The different models of integration, as defined by Meyer et al. (2010) and Stinson et al. (2009) are presented in Chapter 2 as well as Appendix C. Table 2 displays the percentages of each type of integration, as represented by the collected lesson plans.

Table 2

Type of Integration as Represented by Lesson Plans

	Brenda	Max	Mel	Rachel	Stephanie
Process	40%	40%	40%	40%	40%
Pedagogical	40%	0%	0%	20%	0%
Thematic	0%	20%	0%	20%	40%
Inter-Disc.	20%	0%	0%	0%	20%
Project	0%	40%	40%	0%	0%
Simultaneity	0%	0%	20%	20%	0%

Through the use of all data sources, and an employment of triangulation of data as a method of establishing quality, themes emerged. These themes reveal answers to the research questions. The study revealed that the definition of science content integration and the use of science content integration were linked.

Findings

There were three research questions for this study. First, how do teachers individually define science integration? Secondly, how do teachers use science integration in their classrooms? Lastly, what do teachers perceive as impediments to content integration? The study revealed data that answers each of these three questions. Typically, integration was broadly defined by the participants as a practice where objectives from more than one curricular area are targeted simultaneously within one lesson or activity. More specifically though, participants revealed that the most commonly accepted use and definition of science content integration represented the model characterized as *process integration*, where a skill in one area of the curriculum is used to acquire knowledge or skills in another area of the curriculum (Stinson et al., 2009).

Six themes emerged from the data and were the following: (a) student population affects teacher definition of integration; (b) process integration is the most common form of science content integration, followed by thematic integration; (c) the most common use of science content integration is reading exercises based on nonfiction texts; (d) most science-based hands-on activities usually involve integration of math and/or language arts; (e)the lack of suitable materials is an impediment to science content integration; and (f) Teachers feel that they could provide higher-quality science content integration if they had additional time for planning and collaboration. Direct quotations from participants in support of each theme are presented in Appendix F.

Regarding the question of how teachers defined integration, the study found the following themes: (a) student population affects teacher definition of integration (i.e. age level, special education, gifted, etc.); and (b) process integration is the most common form of science content integration, followed by thematic integration. The second theme also applied the use of integration, which was the focus of the second research question explored by this study. Responses from all three data sources support this theme, while it is based on both the personal meanings teachers ascribe to content integration as well as observed practices.

Two other themes described the use of integration: (a) the use of nonfiction texts during reading activities is the most common form of science content integration; and (b) most science-based hands-on activities usually involve integration of math and/or language arts. It was difficult to separate data related to the definition and use of science content integration, as both of these were dependent upon the student population that each participant worked with.

The third research question asked what teachers perceived as impediments to science content integration. According to the data gathered by this study, two themes emerged:(a)the lack of suitable materials is an impediment to science content integration; and (b) Teachers feel that they could provide higher-quality science content integration if they had additional time for planning and collaboration.

Data revealed that some teachers integrate out of necessity, while others use it as a way to enhance instruction, whereas for still others, content integration remains an ideal aspired to but not always achieved. The use of tactile, hands-on learning experiences, and the balance with classroom management is ever present. Some interview responses were centered upon science education as a whole rather than science content integration. These data were not directly relevant to the research questions, but they are included because they display the complete image of the issues related to teaching science. These data are summarized in Table 1.

Definition of Science Content Integration

Teachers defined science content usually in the way of process integration, with smaller indications of simultaneity. For teachers of younger students, and those who teach special education students, integration was defined as the use of a theme to naturally connect various areas of the curriculum.

Participants' definition of integration was loosely similar according to opening statements during the interviews. Participants stated that, broadly defined, content integration involved teaching objectives from different content area simultaneously. However, further along the data collection process, it soon became apparent that the definition of integration was largely dependent on its actual use by participants. Thus, the definition was dependent upon actual practices of participants, and the practices of the participants were directly dependent upon the needs and age levels of the students.

Brenda. When asked what it means to integrate subject areas, Brenda responded:

> To me, what it means is, when you're teaching any type of subject, you are using other subjects at the same time, so if you're teaching math, you might bring in social studies, or any other subject at the same time that would give you the opportunity to say that you've taught that as well. A lot of times with science, I incorporate a lot of language arts with it with writing and reading, and I also incorporate it a lot with math. Between those, I feel like I cover a lot of areas that go along with our objectives.

When she discussed what she taught and how she taught, her practices were rooted in what the students were required to learn. For example, when I asked a follow up question regarding her use of hands-on learning, she made a comment about using measurement in science and math.

Max. Max defined integration as focusing on a standard through different curricular lenses. Max offered the following comment: "You are pinpointing, but try to combine as many areas of thinking as a way to do that." Max's particular understanding of integration is based upon process integration (Meyer et al., 2010). Most of his examples of integration, with regard to interview statements, lesson plans, and recorded audio of lessons, reveal the use of a skill or knowledge pertaining to one area of the curriculum being used in another area of the curriculum.

Mel. When asked to define integration, Mel responded with a comment that alluded to testing pressures:

> I try to use a lot of…You know, maybe integrate it more with writing after we do maybe little lab experiments we do maybe with the lab write ups. They have to be complete sentences using…I mean, using hooks. I mean, even though it's science. Just incorporating the same things we've been using for our writing for the writing test. And then also trying to incorporate the math part of it into the experiments.

Like Max, Mel also defined integration as process integration (Meyer et al., 2010; Stinson et al., 2009).:

> Well, first of all, it's kind of doing double dosing. They're getting a little bit of both. Two, I think it's important for them to see that each subject kind of goes along with each other…You know, you can write in science and you can do math in science. During reading, do science. You know, everything, it kind of, it's not just one subject. They kind of all coincide…They work together, in different ways.

Rachel. Rachel, a first grade teacher, provided a definition of integration that is indicative of thematic integration: "…Where you take a theme, and everything you do goes around that theme, and it's all intertwined." Following this comment, Rachel cited the value of the practice: "So it's trying to get the best bang for your buck, a double-duty type of thing." Rachel's definition of integration being more thematic than process-based (Meyer et al., 2010) was in contrast to the other participants. The students that Rachel teaches are younger than those taught by other participants. However, Brenda, a second grade teacher employed a type of process integration that came very close to resembling thematic learning. At times, Brenda stated that she would use a science subject where she would use other subjects to teach the science concept. In this way, Brenda's use of a science objective as a theme resembled Rachel's thematic integration.

Rachel offered the following support for why she defined content integration the way she did:

> Because it seems like the students I have right now are very focused in. They're very narrow-minded with their thinking. They don't see things in the big picture. It's like, if you're talking about money, then it's only money that exists at that moment. And I'm trying to get them to think outside the box and to broaden their thinking.

Rachel commented that her definition of integration and her thematic practices were based upon: (a) her training; and (b) what experience taught her was effective for students.

Stephanie. When asked to define integration, Stephanie commented that her definition of integration was process integration, but with a focus on reinforcing skills rather than acquiring new skills. Stephanie stated: "That, to me, means combining subjects and subject matter, in any way possible. In order to reinforce skills. In that area and another area."

Use of Science Content Integration

Some teachers mentioned the use of charts, tables and graphs, bridged with hands-on activities during science lessons. In the state of Georgia's curriculum, the use of charts and tables falls under the umbrella of math and language arts objectives. According to the Georgia Department of Education's website (www.doe.k12.ga.us) the following is listed as a fourth grade language arts objective: "Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears" (Georgia Department of Education, 2010). Additionally, further examination on the website reveals similar listings of standards and objectives under math and science areas. Therefore, listing, displaying, and reading data on charts and tables is a math, science and language arts objective in the State of Georgia.

One trend that emerged from the data is the use of themes, particularly with the lower grades (i.e. kindergarten, first and second grade) was the use of hands-on activities (in third grade and special education classrooms) to connect math or language arts to science. Special education teachers integrated science with functional skills, such as brushing one's teeth or combing one's hair. In the data gathered, it was found that this is usually done through analogy. The participant in fifth grade used integration to ensure participation of students as test preparation is usually a primary concern.

The practice of special education teachers integrating life skills with science content is supported by Ayres, Lowrey, Douglas, and Sievers (2011), who wrote that when students with disabilities work on these skills through a curriculum, rather than isolation, acquire more “meaningful” knowledge (p. 14). The definition and use of science content integration were entwined. This did not apply to only special education teachers, however. According to interview data, lesson plans and audio recorded lessons, all participants’ definitions and uses of content integration were based, in some way, on the student population that they served. This was indicative of the practice of differentiated instruction as a whole. Though all participants gave responses that described their varied uses of integration, the data was most pronounced with Stephanie, the special education teacher.

Stephanie and Rachel were the participants who provided the most data related to thematic teaching. Rachel, a teacher serving first grade students, indicated that she integrated content for two primary reasons: (a) She was trained to integrate thematically in teacher-preparation courses; and (b) Thematic teaching was, according to her experience, effective in addressing the learning needs of her students. She stated that these comments were based on her experiences with this age group. Max, a third grade teacher serving gifted students, also served as a source of data highlighting the application of thematic teaching. However, it is important to note that this was Max’s second year as a third grade teacher and that he had previously served as a teacher of kindergarten students. The fact that Max recently worked with students who are only a year younger than Rachel’s students might be one reason for their similarities in comments.

Brenda, a teacher of second grade students, centered most of her feedback on hands-on learning. According to the data she provided, a hands-on activity in her classroom often served as a vehicle for science content integration. The activity would provide a bridge between science, and math or reading. Sometimes, all three areas would be combined. The type of integration in this instance would be process integration, where knowledge or skills in one area of the curriculum are used to gain or develop knowledge and skills in another area of the curriculum, according to Meyer et al. (2010).

Differences in the practice of content integration exist due to the factors of different age levels of students as well as the differences in educational needs. The use of integration and various age levels is summarized in Table 3: Use of Integration and Age Range.

Table 3

Use of Integration and Age Range

Age Range of Students	Use of Integration
6-7	Use of Themes to Naturally Integrate entire curriculum
7-8	Use of Hands-On Learning to connect science to math writing, and reading.
8-10	Use of Hands-On Learning to connect science to math writing, and reading.
10-11	Capitalization of Student Interest in Science to teach and reinforce skills in Language Arts and Math. Sometimes used as Test Preparation.

Data revealed that teachers of various populations had a different use for integration. Teachers with students with special needs integrate science content for very different reasons than teachers of students who are in regular or gifted education. These differences hold major contrasts for the practices of teachers, in that students at different age levels have different needs for learning, as well as different standards and objectives. These differences are summarized below in Table 4.

Table 4

The Use of Integration and Population

Population of Students	Use of Integration
Special Education	Integration of learning objectives with life skills, or life knowledge (e.g. brushing teeth) to reinforce and review learning, characterized by frequent use of nonfiction texts in reading activities.
Regular Education	Integration of science with math/language arts through the use of themes or hands-on learning activities to gain or reinforce knowledge, characterized by frequent use of nonfiction texts in reading activities.
Gifted/Advanced Education	Integration of creativity and/or hands-on learning that connects science to math, reading and writing.

Impediments to Science Content Integration

The lack of suitable materials was often seen as an impediment to science content integration. Teachers indicated several times that there were not suitable materials. In some instances, teachers had to design their own materials to suit the needs of the curriculum, the needs of students, or the practice of integration. Additionally, some participants gathered materials through novel means, such as piloting and previewing a curricular program from a publisher.

Another such impediment to integration was the use of time. Many participants indicated a desire to have more time for planning. One participant, Max, commented that because of the schedule, he was not able to have a “planning period”. Another participant stated that integrated activities required planning, but he or she desired to have “another hour in their school day” to meet the demands of planning for an integrated classroom. A third participant cited the effectiveness of common planning time, and teacher collaboration. When asked why they felt that this was not more common in the classroom, they stated that it was an issue of “priorities”. This comment was followed by a description of the priorities of those who administer school practices (i.e., “higher-ups”) and fellow teachers. With respect to fellow teachers, Max highlighted all the duties and responsibilities of a classroom teacher that would most likely overshadow planning. Mel also commented that his time for professional development is minimal, given the other duties and responsibilities of a classroom teacher. As such, he indicated that the professional development and/or collaborative planning should be something that teachers are provided time for during the actual school day.

The Hands-On Component

Hands-on learning emerged as relative to the research questions. All participants made mention of hands-on learning in statements. From the data gathered, it seems impossible to separate the subject of hands-on learning from the subject of science content integration. All participants provided evidence that hands-on science learning usually involves skills from other areas of the curriculum. One participant, Brenda, seemingly equated hands-on learning to science education. Her comments were so passionate, that at one point the researcher strayed from the interview protocol to ask which she would sacrifice if she were required to do so: science content integration or hands-on learning. She commented, “I would sacrifice integration. I hate to say it, but I would. But it’s so important…”

Some participants stated that a lack of physical materials (e.g., plastic cups) prevented science content integration from taking place. Others stated that the way they integrated science content involved hand-on learning activities. Interview comments offered by each participant on the use of integration are provided below:

Brenda. Brenda’s use of science content integration tended to be based on hands-on learning activities. Additionally, she stated that she used integration during reading activities. Brenda stated:

> I do a lot of reading with them, but I do it, I do a lot of reading during science, but I also, during my small group guided reading, I will pull my same science books and use them then. But I know it’s important for them to hands-on activities as well.

Brenda prized the hands-on activities that she used with to a high-degree, at one point she criticized teachers at other schools:

> But I’ve heard a lot of other teachers at other schools say that since science isn’t important to them, that the only thing they would use would be pulling out the science books and reading with them and not doing any of the hands-on things for science which they need to be doing, and I totally disagree with that.

Following up to these comments, I asked her why she chose to integrate. Her response was directed towards the students' needs at their age level for hands-on, tactile learning experiences that allow students to use skills from multiple areas of the curriculum. Brenda used hands-on learning experiences as the construct (Meyer et al., 2010) for the integration of many types of subjects. She completed her response with the following statement: "I don't think there's a way that you can't do it."

Max. Max commented that he integrated math and/or language arts with science when conducting hands-on learning activities. Max revealed this practice in the following interview statement:

> On most all my science experiments that we do biweekly they involve…the first thing is their charts they do on their science experiments and their numbers. They're data thinking. Collecting data and manipulating data in some way. You know we just, we just got finished with heat. Had a huge deal with the numbers and the computation. You know what I'm trying to say…The adding and subtracting of heat.

However, he stated that he also employed integration with reading practices. Max stated: "I see myself doing this more in my reading groups. Or reading in science and writing in science. Or math and reading in math and problem solving in math. Just throwing all those things together". Max also stated that part of understanding the practice of integration is to make sure students have the prerequisite skills prior to beginning an activity. Max stated:

> We talked about data collection. That was one of the first nine weeks objectives. In the AKS. And we talked about that. I think, a lot of times, if you say data

> collection in kindergarten, they would have no idea what you are talking about. However, if you did a small science experiment with them, with kindergarteners, they collect data. You can teach them how to organize it in a chart. They are essentially doing it without knowing that they are doing it. So, yes and no according to how deep you go into the content knowledge of what they are doing. But yes, for the most part in the math strategies that we use, for the most part, they have to be able to find the difference in numbers and the difference in temperature as well as those science and math words.

Mel. Mel's use of science content integration was heavily based in writing activities. He stated:

> I try to integrate writing with science, because I think it's more challenging for them to use that with science than just with writing, and it's also practicing those concepts, even if it's just a paragraph. They still have to integrate the science content with the writing content.

Mel also stated that many times he would use the inherent excitement offered by hands-on science learning to get the students excited about another subject in a different area of the curriculum. Mel's integrated practices were also rooted in standardized test preparation.

For this specific environment, fifth grade was a high-stakes testing population. Mel stated that he tended to focus most on writing because of an upcoming system-wide writing test: "I know this is terrible but there's more emphasis within the school and the county on writing so there's more pressure."

Rachel. Rachel used themes to integrate all subject areas. Her primary practice for this was in reading groups. Rachel commented:

> Now we're doing a workshop and calling it guided reading. But I still feel like its incorporating. Like, for example, my theme this week is like groundhogs and talking about light and shadow. And so, during readers' workshop, I would read a book about light and shadow, and talk about both comprehension for the reading portion, then I'd talk about light and shadow for the science.

Rachel stated that the primary reason for her specified use of integration was that she felt that current practices were "disjointed". She felt that, pedagogically, students at the first grade level needed themes to connect different areas of learning.

Stephanie. Stephanie tended to blend all areas into reading practices for her students. She stated:

> For reading, we will go over the material as part of our reading group, to reinforce the vocabulary and to work on the content as well. But to also work on their reading skills. Especially with them having bigger words that they are not used to reading. And they also do very well with that. But also like in math, combining reading with math, as in math word problems, that kind of thing.

Additionally, because of the special needs of her students, Stephanie integrated the learning of life functional skills with multiple areas of the curriculum. Stephanie commented that the recent changes in special education requirements have forced drastic changes on teachers of students with special needs. Alluding to the past, she stated: "We were responsible for our IEP goals and objectives alone. That was it. And we did not have to teach science and social studies because it was not on the IEP's." However, by integrating science into reading activities and by integrating all subjects with IEP goals, Stephanie is able to meet multiple specific needs of a diverse group of students.

In order to arrive at these findings, I had to rely upon data analysis techniques that forced me to examine connections within the data. Through repetition of codes, and emergent connections, themes emerged. These themes form the core of the findings, which relate directly to the research questions.

Patterns, Relationships and Themes

The need for planning time was highlighted in several instances. Part of the need for this is centered upon the lack of integrated materials and lessons for teacher use. Most participants described their practice of integration rooted solidly in the learning habits of children. A strong theme revealed by the data is "I integrate because that is how children learn." This was even more profound among participants who worked with special education students.

The themes that emerged from the data were based on a coding process where a large body of codes was condensed to 43 in number. Afterwards, after examining related codes and unsupported codes, a process of merging two or more codes into one convened. Some codes were discarded. Codes that were relevant to science education but not related directly to the research questions are listed in Table 2. All remaining codes were combined into the condensed codes, which are shown in Appendix E: Frequency of Condensed Codes. The six themes that emerged from the study were the following: (a) student population affects teacher definition of integration; (b) process integration is the most common form of science content integration, followed by thematic integration; (c) the most common use of science content integration is reading exercises based on nonfiction texts; (d) most science-based hands-on activities usually involve integration of math and/or language arts; (e)the lack of suitable materials is an impediment to science content integration; and (f) teachers feel that they could provide higher-quality science content integration if they had additional time for planning and collaboration.

In any qualitative study, the establishment of quality is a requirement (Creswell, 2007). In this study, the two sources of quality were the trangulation of data, and member-checking. Additionally, prior to beginning the study, I had to locate appropriate participants who would be able to provide the data needed to research this topic.

Evidence of Quality

The completion of this study involved several complex steps. First, I located willing participants who claimed to be practitioners of science content integration. Each participant was provided with the letter of invitation as well as other documents. All participants signed informed consent forms prior to the research. Second, I scheduled interview times that were mutually available to the participants and me. Once these interviews were scheduled, I used a digital recording device to audio record the lessons and transcribe them personally.

After interviews were conducted, I worked with the participants to arrange times to audio record science lessons. These were recorded digitally by the participant and I transcribed the words of the participant during the science lesson. The participants then furnished science lesson plans in the format they chose. I used the lesson plans and analyzed them using the Lesson Plan Review Document, which is presented in Appendix C. Appendix D displays a sample of the lesson plans provided by each participant, along with his or her analysis.

The 10 codes which are displayed in Appendix E: Frequency of Condensed Codes were the result of the triangulation process. During data analysis, initial coding was done simultaneously, however, codes were retained within their sources (i.e., codes from interviews and lesson plans were not combined). After the initial coding, the codes were then modified according to their recurrence, in that some were deleted and some were combined for each data source. If a code recurred at least five times, then it was compared to other data sources. For the code to be placed in list of condensed codes it had to be supported by at least one other data source. Later, during the establishment of themes, all three sources of data were needed for validation. All of the themes of the study are supported by all three forms of data.

The final process for the data collection and analysis in the study was the member-checking process. Member-checking was explained to each participant prior to their signing on to participate in the study. During this process, I met with each participant individually and explained both the research methodology as well as the findings of the study. The participants agreed with their representation in this study, and agreed with the findings. No participant found fault with the methods or with the findings, though both Rachel and Stephanie stated that they were unaware of the practices of other teachers. They found the results enlightening. Stephanie specifically felt removed from the practices of others due to her isolated function within her school. During her member-checking meeting, Stephanie stated, “Wow! I never knew that, but I guess it makes sense. I mean, if I was in a regular ed. classroom…”

Conclusion

Overall, the findings from participants reveal that teachers have a desire to integrate science content, but the impediments of unsuitable materials and lack of collaborative planning time are obstacles to this practice. Participants indicated that in order for them to increase the quality of integrated learning experiences, and science education as a whole, time for professional development should be provided throughout the school day. The current trend for teachers in a suburban Georgia school is to focus primarily on process integration, and seconded only by thematic integration. Thematic integration is used more with younger students. At all grade levels the most prevalent use of integration is the presence of nonfiction science texts during reading lessons and activities.

Teachers integrate content, but how they do it, and the definition they ascribe to it, are directly related to the teacher's position within a school. Though these different practices and behaviors may relate in some way to teacher training and preparation, the strongest contributing factor in determining the individual's definition and use of science content integration are the students themselves. Within the scope of this study, these findings bear a positive message, which is that teachers are differentiating instruction to meet the specific needs of a defined student population. Section 5 follows with a discussion of the findings, as well as conclusions and recommendations.

Section 5: Discussion, Conclusions, and Recommendations

Introduction

This study was conducted to explore the definition and use of science content integration, as well as perceived impediments to integrating science content. These concerns included: (a) lack of knowledge in best practices concerning the teaching of science, and (b) a lack of consensus on the definition of content integration. Though research supports the effectiveness of content integration (Alexander et al., 2008; Bergmann, 2008; Card, 2005; Lawrence, 2007; Reed & Groth, 2009), the problem concerned the several definitions of what it means to integrate content (Meyer et al. 2010), and there was no consensus locally. In this study, I sought to understand what content integration means to individual participants, and how it is commonly utilized in their practices. Additionally, I investigated what teachers perceived to be hindrances to common implementation of science content integration. As mentioned in Section 4, the six themes that emerged from the study were the following: (a) student population affects teacher definition of integration; (b) process integration is the most common form of science content integration, followed by thematic integration; (c) the most common use of science content integration is reading exercises based on nonfiction texts; (d) most science-based hands-on activities usually involve integration of math and/or language arts; (e)the lack of suitable materials is an impediment to science content integration; and (f) teachers feel that they could provide higher-quality science content integration if they had additional time for planning and collaboration.

Interpretation of Findings

Three research questions guided this study. First, how do teachers individually define science integration? Second, how do teachers use science integration in their classrooms? Last, what do teachers report as impediments to science content integration? With respect to the first research question, I found that most teachers defined science content integration as the implementation of lessons or activities that involved process integration, as defined by Meyer et al. (2010). The second most common form of science content integration involved the use of themes, and this practice was more common with teachers of younger students.

Process integration involves using a skill prevalent in one area to teach objectives in other areas. Examples of this implementation of integration were using charts and tables (which are language arts objectives) to teach science, often through a hands-on activity. This same trend was seen with the use of grammar and writing in hands-on science labs as well. However, the most common content integration is with the combination of science and reading, in the form of using nonfiction science texts during guided reading groups. These data involved the second research question. The unexpected finding was that the answers to the first two research questions were one and the same. Teachers defined science content integration according to how they used it. Their use of science content integration depended on the students they taught. The finding was that all teachers used process integration, but those who taught younger students, or students with remedial needs were more likely to employ thematic teaching. These data and findings only apply to the focused scope of this study. Future studies must be conducted to examine whether or not the same findings apply to different samples of participants within a suburban Georgia area.

As described in Section 2, science education in Georgia is a highly complex subject. The data from participants indicated many avenues of research that could be conducted. Participants are ready to speak about their practices and beliefs, but they must have an avenue to do so. This study provided one such outlet. During the interview process, there were many occasions when a participant would take the research in a different direction than expected. Their comments revealed a wealth of data pertinent to the research questions, but also indicated that there are many other aspects of science education that require investigation.

Professional development practices played an important role in the data. Participants were slightly divided on their opinions of professional development in general. However, their comments are to be weighted by the fact that the participants attended different events. For example, both Max and Rachel held professional development in high regard, as it was conducted by peer teachers and provided them with instantly applicable ideas and techniques. Rachel specifically mentioned that having professional development provided by a teacher who works with the same age-level made the sessions beneficial and worthwhile. Other participants found professional development offerings “useless” (Brenda). Mel commented that his personal time was valuable and that for him to attend a session, he would prefer that time be provided during the instructional day.

The participants’ comments supported the use of mutual planning as a form of professional development. A lack of time, for planning integrated science lessons mutually, is viewed by this study as an impediment to integration. Another impediment is the lack of materials. Three different participants, Brenda, Mel, and Stephanie commented that a lack of materials was an impediment to science instruction generally and integration specifically. Stephanie experienced so many issues with located suitable materials that she felt the need to create her own.

The evidence of this study is bounded within its scope. These data were only taken from a small sample of teachers in a suburban Georgia school. These data and findings apply to this group of participants from this purposeful sample. It would be unreasonable to generalize the results of this study to all teachers in the state of Georgia, but they may be applied to similar groups of teachers in similar areas of the state. However, this topic should be the focus of future studies. Though these participants demonstrated bold contrasts among one another, there were trends and similarities that arose from the body of data, the strongest of which is the trend that a teacher's belief and practice within the concept of science content integration directly depends upon the students that the teacher serves.

As students ascribe meaning in the constructivist theory, the same is true of teachers participating in this study. The participants' definitions of science content integration were rooted in their practices and experiences. For all participants, the data show that teachers used students' pedagogical needs for planning and implementing integrated learning experiences. Experiences of the participants affected their beliefs and practices.

The difficulties teaching science, as outlined by Owens (2007) are represented by the comments of the participants in this study. One teacher, Mel, expressed difficulty in becoming familiar with the curriculum. This teacher is relatively new to teaching science, and specifically new to teaching science on his grade level.

I found that teachers determine meaning from practice. Science content integration holds different meanings for different teachers. A similar finding was discovered by Stinson et al. (2009), who found that teachers do not always agree on what is and is not integrated teaching. Stinson et al. (2009) wrote:

> Ultimately, this study reinforces the need to provide teachers with a clearer understanding of what mathematics and science integration is and is not. In the absence of clear characterizations or parameters for what constitutes integration, teachers apply their own criteria based upon their knowledge and beliefs. (p. 159)

However, the findings of this study contrast with Stinson et al., because that study was conducted with middle school teachers and limited to only on math and science content integration. This study used different data sources, using elementary school teachers as participants, and focused on the broader subject of science content integration with any content area. In this study, I found that the determining factor for a teacher's definition and use of science content integration are the students.

When the results of this study are examined through the lens of current research on education in the state of Georgia, the themes take on a greater meaning. For instance, the participants' reliance on process integration and thematic integration is challenged somewhat by Foutz et al. (2011), who supported project-based integration. Foutz et al. (2011) defined project-based learning as "an approach where the central focus is to engage students in a project that investigates the concepts of a given discipline or disciplines" (p. 29). At the same time, however, Foutz et al. (2011) highlight the need for mutual planning and/or professional development that is directed at teacher collaboration.

Foutz et al. (2011) encouraged school systems in Georgia to follow the example of the Jackson County school system, which created a professional development program in conjunction with the University of Georgia, consisting of mutual planning between math and science teachers in all grades. The teachers met on a monthly basis to plan activities and assess the program's effectiveness. This program was based on connecting math and science (as well as other areas of the curriculum) through agriculture. The type of integration that was emphasized through this program was project-based learning. However, according to the manifestations of integration as defined by Stinson et al. (2009) and Meyer et al. (2010), this practice could be modified to make it seem more like thematic integration.

In the Foutz et al. (2011) study, students were given problems to solve, and their proceeding educational experiences were aimed at attempts to solve these problems and address these issues through projects. Foutz et al. (2011) offered the following examples of issues that students were asked to address through integrated learning projects: "(a) how to maintain and utilize the natural resources in order to have an economically viable working farm; (b) how to assess the effects that the subdivision and farm would have on these natural resources; (c) how to maximize the positive impacts that the farm would have on the subdivision and vice versa; and (d) how to minimize the negative impacts that the farm would have on the subdivision and vice versa" (p.26).

According to Page (2010) support for educational leadership in Georgia is required for any local or state-wide positive change. Leadership is responsible for decision-making regarding professional development practices as well as acquisition of learning materials for schools (Page, 2010). The results of this study identified these same subjects as impediments to integration. The teachers in this study only favored professional development practices directed and implemented by their peers and that also provided them with an opportunity to learn from one another while sharing ideas.

While leadership might be primarily concerned with test scores (Page, 2010), taking the themes of this study into account has the potential to address that issue. For instance, Foutz et al. (2011) have shown that project-based content integration can raise scores in multiple areas of the Georgia CRCT standardized test. Foutz et al. (2011) reported that the initial results were a 26% to 54% increase in test scores, in both math and science. Prior to a workshop based on teacher mutual planning, students were performing below the state average on the science CRCT. After the implementation of the workshop, science test scores increased approximately 3% per year until the scores reached a level above average for the state of Georgia (Foutz et al., 2011). Foutz et al. also reported increases in math CRCT scores.

One of the notable facts about the Foutz et al. (2011) study was that the theme of the actual project, agriculture, is not an objective for the Georgia students who were part of the study. It was merely a binding element for different areas of the curriculum. Though some items may not be science standards, they can, in fact assist students in acquiring mastery of science standards by integrating knowledge valued by the community with science learning and activities (Hodges & Tippins, 2009, p. 3).

Though this study is centered upon suburban Georgia, situations regarding a lack of materials and mutual planning time are also present in rural areas of the state. Hodges and Tippins (2009) studied rural Georgia, which suffers from many issues that are not present in suburban and urban schools. For instance, teacher attrition in Georgia is high (Iosova, 2010) but it is highest in rural areas (Hodges & Tippins, 2009). Teachers in rural areas leave the profession and/or specific schools much faster than in other teaching environments (Hodges & Tippins, 2009). And though Hodges and Tippins reported similar complaints regarding materials as the participants in this study, the real cause of attrition was teacher frustration. Hodges and Tippins stated that oftentimes schools in rural areas of Georgia do not hold any mentoring programs at all. Hodges and Tippins also stated that at some of these schools, most teachers do not experience "in-field professional development" (p. 2).

While Lawrence (2007) wrote that teaching science in Georgia is difficult, due mainly to the scope and sequence of state standards, difficulty and frustration can be mitigated through support and guidance of educational leadership (Jarvis, 2009; Page, 2010). Leadership has the power to mobilize programs exploring the different manifestations of content integration and their uses for different populations of students, as well as to eliminate the impediments of content integration which are a lack of materials and/or mutual planning time.

Practical Applications of Findings

These findings could be immediately applied to the design and implementation of professional development opportunities for teachers. It is suggested, based on the findings, that schools present teachers with opportunities, during the instructional day, to collaboratively plan and develop lessons. Time for planning and lesson development proved to be a factor in teachers' practices of integration. Teachers of lower age-levels might seek to use themes, whereas older students might need hands-on experiences to bridge the gap between curricular areas. School leaders and district supervisors should pay attention to the results of this study in taking into account time and resources allotted for teacher planning and development. Stinson et al. (2009) wrote, “Professional development experiences focused on integrating mathematics and science should involve attention to strategies and tools that may uncover teacher perception of what it means to integrate these disciplines” (p. 160). I agree with this statement, however, I believe that professional development should include ways to integrate all subjects with science, rather than just mathematics. Additionally, the professional development should be individualized according to the population which teachers teach, as the findings of this study suggest that student populations shape practices.

Implications for Social Change

The greatest benefit for social change will come from data use to inform professional development offerings in local schools. The data reveal that there is a clear and present belief, among the participants in this study, that content integration is held to be effective in supporting teaching and learning. At the same time, participants cite the need for additional time to collaborative planning. Teachers in this study state that they integrate because they feel that they must because they believe that that is how their students learn, and that is how they may best serve them.

However, teachers feel that there are some issues that need to be corrected if they are going to meet the modern demands of teaching science in the state of Georgia (Owens, 2007). The lack of suitable supplies and materials in indicated by the data to be a hindrance to instruction. Additionally, teachers desire time for collaboration and mutual planning. According to data from the study, teachers find professional development most beneficial when it comes from their peers. According to statements provided through interviews, participants note examples of being able to put into use techniques, methods and lessons acquired from peers. District and school building leaders should pay heed to this idea and attempt to capitalize on it for the benefit of students.

The findings of this study can be used to assist districts in planning to have more support in the schools, at a local level, fostering a general improvement in science instruction, the procurement of science materials and the provision of time for teachers for instructional planning and collaboration. Additionally, understanding the differences in how teachers teach, according to age level and specific needs of students, can allow teachers to share their talents and strengths. Teaching technique should be aligned to the instructional needs of students, and the instructional needs of students should drive decisions concerning the purchasing of instructional materials. Funds are a finite resource, and so should be allocated with knowledge and expertise.

Recommendations for Action

I recommend further studies to evaluate the effectiveness of science content integration, and the impact on student performance. Whether or not these studies should use test scores as a source of data should be a decision of individual school districts. Additional studies should also be conducted on the use of time as a resource in elementary schools. There should be investigations on the effect of providing teachers with more time to plan learning activities and collaborate.

Three groups of people should pay attention to these results: (a) fellow teachers, (b) district and building leaders, and (c) researchers. Fellow teachers have much to gain in understanding how their peers approach the practice of integration. This will allow them to alter or strengthen their own practices. District and building leaders should be careful in how they administer professional development practices. The participants in this study mentioned “time” as a resource more so than all material resources combined (e.g., books, equipment). Teachers place high value on planning time, as well as personal time, and if schools wish to maximize the impact of professional development on their staff, they should allot opportunities that teachers will both find beneficial and be able to put directly into practice.

Recommendations for Further Study

Researchers should take the results of this study and apply them to other future studies. There is so much that needs to be understood regarding both science education as a whole and science content integration specifically. First, we need to understand if the practice is effective. There is a belief in the participants of this study that it is. However, the potential effectiveness of content integration was beyond the scope of this study. Concrete evidence is needed to prove or disprove the belief. Also, is the practice more effective with different populations? Researchers should also examine the practices and beliefs of teachers in other geographical areas. Future studies should examine the practices of teachers at various settings to reveal whether or not results coincide with the findings of this study. A similar study should be conducted to investigate whether or not findings are similar with other participants in other geographical areas.

Reflection

Conducting this study has been a life-altering event for me. I was able to witness and understand the beliefs and practices of fellow teachers on a very intimate level. I now believe that though teachers often are seen working together, they are still very isolated in their practice. From the data in the study, the lack of collaboration and the desire to collaborate were evident. Prior to this study, I gave little though to the notion of collaboration. I also more or less believed that all teachers really held the same beliefs and carried out the same actions. I now understand that the population of students one has, truly affects both their practices and beliefs about teaching.

Prior to beginning this study, I clarified my own biases. Since the inception of the No Child Left Behind Act of 2001, I have held a negative opinion of state-wide standardized testing. I have personally also held the belief that not enough attention was provided to elementary science education in the US, and more specifically the state of Georgia. However, during the course of this study, my biases have changed. I now see science, math, and reading as all dependent on one another. At least, that is how the teachers in this study treat the subjects. My views on standardized testing remain somewhat negative, though my opinion is not as strong as before. Prior to the study, I viewed testing as the culprit for the reduction of time and other resources dedicated to science. However, the participants in this study have used novel means to embrace the change while meeting the ever-present demands of elementary education.

I do not feel that the participants were changed by this study, but I do feel that the member-checking process opened their eyes to the similarities and differences of fellow teachers. Perhaps the findings of this study can serve as the starting point for more collaboration and mutual cooperation. Teachers have different beliefs on the intent, definition of, and use of science content integration. However, underlying these differences is the inherent belief that integration is “good.” Somehow, regardless of differences in practice and background, participants felt as though integration can benefit students. As a classroom teacher, I have found myself integrating both intentionally and unintentionally. At all times, it simply felt as though that was "what worked." My most recent role in the school has consisted of serving as a science specialist, where I teach hands-on science lessons throughout the day to all age levels of students. I found it impossible to perform this role without the integration of math and language arts objectives, and so I would practice content integration on a daily basis. Now, as a result of this study, I understand that others feel the need to do the same.

Conclusion

The greatest outcome from this study is the potential to influence professional development. An integrated program should be carefully constructed. First and foremost, teachers already practice science content integration during hands-on learning activities in science, and reading lessons. The most recurrent theme is the use of nonfiction science-based texts during guided reading groups. Other areas of the curriculum are often integrated as well, but reading integration is the most common.

This study calls upon educational leaders to provide attention to the need of teachers to collaborate during the school day. One participant, Max, commented that collaborative planning was not done more often was a situation of "priorities". The many demands that teachers current face might detract from the practice of collaboration. However, if teachers are not asked to stay late, or partake in training over weekends, then they might be more accommodating with teacher-training requests. Many participants' comments regarding "training" alluded to the lack of usefulness of professional development. Some commented that having gone to so many sessions, there was little that could be put to use in the classroom, or so little that was new.

Participants indicated that the best professional development practices were ones that were directed by their peers rather than an outside source. Rachel commented that having professional development conducted by a fellow teacher allowed her to gain additions to the repertoire of her practice that she could immediately put to use. Rachel mentioned that having the facilitator of this professional development was a teacher on her same grade level made this session successful. Rachel commented that she was able to use some of the lesson ideas that were presented at the professional development class.

Integration holds the possibility of allowing teachers and school districts to maximize instructional time. The importance of science content integration and its potential to improve educational experiences for students is best summarized with a quote from Max:

> I feel like, I mean, through research that I have read, and through the impact that it has made on my students, their knowledge when we go to other subject areas and see their interaction in other subject areas, that it makes a huge impact. Once it all connects, it's a net support of education. Everything goes together and intertwines together. Everything needs everything to survive. We need math to understand different things that we read. We need math to understand science. We need reading to understand something to read that has something to do with math. It's a net of support and I think when they understand that it's an ongoing and continuous growth. Consistently. You never miss out on any subject area or any

> content if you consistently do it on a daily basis. To help them grow. You're touching every level. Nothing gets deprived.

Understanding the definition and use of science content integration was a necessary step forward in educational improvement. Knowing that differences in teachers' beliefs and practices exist because differences in students exist will pave the way for positive social change. It is my hope that this study will contribute to the body of knowledge concerning best practices for elementary education.

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Appendix A: Interview Protocol

1. What does it mean to you to integrate subject content areas?
2. How do you integrate science with other content areas in your classroom?
3. What differences exist in how various teachers define content integration?
4. In what ways do your colleagues integrate content in ways that differ from your own practices?
5. What professional development practices are in place, at your school, or at the district level, that support the integration of science content with other areas of the curriculum?

Appendix B: Audio Observation Document

What is being integrated?	Content	Processes	Skills
What is the construct for integration?	Theme	Project	Instructional Technique
What is the level of integration?	Equivalence	Dominance	Partial Dominance

Modified from Stinson et al. (2009, p. 154)

Appendix C: Lesson Plan Review Document

1. **Process Integration**-A process or skill in one area of the curriculum is used to attain skills and knowledge in another content area of the curriculum.
2. **Pedagogical Integration**- A process or skill in one area of the curriculum is used in the context of another area of the curriculum (e.g., an example or analogy is made).
3. **Thematic/Concept-Based Integration**- A single theme or concept extends over multiple areas of the curriculum.
4. **Inter-Discipline Integration**- Different content areas are not integrated. However, different concepts within the same content area are integrated (e.g., multiplication and division in mathematics).
5. **Project-Based Integration**- A project or task is completed which requires students to use skills and knowledge from several content areas.
6. **Simultaneity**- Different content areas are taught simultaneously because they are dependent upon one another (e.g., understanding the concept of cause and effect as a reading skill and using this to comprehend the causes and effects of events in U.S. History).

Modified from Meyer et al. (2010, p. 155)

INTEGRATION MODEL	ANECDOTAL EVIDENCE
1. Process Integration	
2. Pedagogical Integration	
3. Thematic/Concept-Based Integration	
4. Inter-Discipline Integration	
5. Project-Based Integration	
6. Simultaneity	

Appendix D: Sample Lesson Plans

LPB1

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Using mathematics to measure and average distances.
Pedagogical Integration	Using measurement and averaging to experience science.
Thematic/Concept-Based Integration	
Inter-Discipline Integration	Comparing/contrasting with creating tables and averaging. All of these are indicated as “math” by the GA Dept. of Education.
Project-Based Integration	
Simultaneity	

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students learned about distance with the use of mechanical toy cars. Students use the cars by pulling them back and releasing them from a predetermined distance. Students measure the distance traveled by the toy cars with the metric system and chart results. Then, they calculate averages and compare contrast performance of various styles of cars. They use calculators to assist in this process.

LPB2

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Reading is used to deliver science fact. Though the goal is to improve reading fluency and vocabulary, while providing students with an introduction to a science concept.
Pedagogical Integration	Reading instruction integrating science content is contextual. The reading process is used directly to deliver science content.
Thematic/Concept-Based Integration	
Inter-Discipline Integration	
Project-Based Integration	
Simultaneity	

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students use a nonfiction book in their reading groups that is on their instructional level and is based on friction. Students then use various objects and test the movement on a variety of sources. Students create anecdotal qualitative data from their observations. Students then use writing to relate their observations and conclusions to the text they previously read.

LPG1

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Students used reading and tech skills to explore a concept in science.
Pedagogical Integration	
Thematic/Concept-Based Integration	Overall focus on simple machines to use science, reading and technology skills.
Inter-Discipline Integration	
Project-Based Integration	
Simultaneity	Students learning and using science, tech skills and reading concurrently.

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students investigated simple machines and matched the names of the machines to an illustration of the object. Then students utilized a Mimeo board (video technology instruments) to explore the workings of the machines and the various functions that they could fulfill. Students were using reading, science and technological process skills simultaneously.

LPG2

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Students used reading and visual arts skills to explore a concept in science.
Pedagogical Integration	Students creating a product in science, which relied upon visual arts methods.
Thematic/Concept-Based Integration	
Inter-Discipline Integration	
Project-Based Integration	
Simultaneity	

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students investigated plant and animal cells while investigating the similarities and differences. Using a variety of materials, such as bits of macaroni, yarn, pipe cleaners, etc. students constructed models of plant and animal cells while labeling the parts and their function. This lesson took place after reading activities using nonfiction texts centered on the subject of biology.

LPL1

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Students are using writing skills and reading skills to explore a science objective.
Pedagogical Integration	
Thematic/Concept-Based Integration	
Inter-Discipline Integration	
Project-Based Integration	Students are required to use writing skills and science knowledge in the completion of a skill.
Simultaneity	

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students conducted research on the use of fossil fuels. Afterwards, they participated in several reading activities that also focused on the use of fossil fuels. Lastly, students were to use the strategies that they learned in writing workshop to compose a narrative entitled “A Day without Fossil Fuels”. Throughout each step of this process the teacher is available to remediate and extend learning activities.

LPL2

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Students use writing skills to reach a science objective.
Pedagogical Integration	
Thematic/Concept-Based Integration	All activities are centered upon plants native to Georgia.
Inter-Discipline Integration	
Project-Based Integration	Students are attempting to complete a project using science knowledge and writing skills.
Simultaneity	

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

First, students participate in guided reading activities focusing on nonfiction texts, which are based on plants that are native to Georgia. Then, students construct graphs with information about plants, and construct Venn diagrams comparing and contrasting the different types of plants. Throughout this activity, students collaborate with one another to offer suggestions and insight. Students are then required to write to offer suggestions and theories that attempt to explain the reasons for fluctuations in populations.

LPM1

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Scientific observation skills are used in producing writing samples. Writing is used to describe scientific observations.
Pedagogical Integration	
Thematic/Concept-Based Integration	
Inter-Discipline Integration	
Project-Based Integration	In order to complete the task, students must use knowledge and skills from both writing and science curricula.
Simultaneity	The completion of the task requires the interdependency of writing and science skills.

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students learned about chemical changes vs. physical changes. Students placed chalk in sandwich bags and then applied repeated pressure to crush the chalk. Over the course of this process, students wrote in their journals descriptions of what they saw and what was occurring. Students drew visual representations as well. Afterwards, students repeated this process, but instead of crushing the chalk with repeated pressure, students added a few ounces of vinegar. They allowed the reactants to combine, and they repeated the recording process of writing a description and creating an illustration. Students would then compare the results and write a letter to a friend describing their findings.

LPM2

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Students are using what they have read to assist them in the construction of circuits.
Pedagogical Integration	
Thematic/Concept-Based Integration	
Inter-Discipline Integration	
Project-Based Integration	Students must combine reading and summary skills in tandem with science skills and knowledge to construct circuits.
Simultaneity	

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students learned about electrical circuits during a guided reading lesson, using a nonfiction text related to electrical circuits. After the reading activity, and teacher led questioning, students then built electrical circuits using aluminum foil, LED light bulbs, and batteries. Students constructed both series and parallel circuits, representing what was described in the text.

LPR1

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Students use language arts skills to gain science knowledge.
Pedagogical Integration	
Thematic/Concept-Based Integration	The use of a concept (shadows) links various activities and lessons from multiple curricular areas.
Inter-Discipline Integration	
Project-Based Integration	
Simultaneity	

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students are to read a text and then to sequence the events in that text. The text is based on a character who discovers that his shadow changes position after the elapse of time. After reading, students are to cut out various images from paper and place these in chronological order according to what happened in the narrative. They are to also write some events that occurred. In addition to this activity, students also replicate the actions of the main character by tracing around actual shadows and observing how they move over time.

LPR2

INTEGRATION MODEL	ANECDOTAL EVIDENCE
Process Integration	Use of word familiarity is used to designate the word “light”.
Pedagogical Integration	
Thematic/Concept-Based Integration	The same text is used as the basis for a reading activity and a science activity.
Inter-Discipline Integration	Students use reading and writing (both language arts skills) in the same activity.
Project-Based Integration	
Simultaneity	

Modified from Meyer et al. (2010, p. 155)

Lesson Summary:

Students are given an activity where they practice the identification of words with the “-ight” ending. They are to sort these. Additionally, they use these in writing sentences. Then, as a follow-up activity, since “light” belongs to this list, students then identify light sources and separate these from objects that do not produce light. Students rely on the use of a text for both activities. In essence, rather than two separate lessons this is a large block of time in which several activities are linked and the same text is read multiple times for different purposes.

Appendix E: Frequency of Condensed Codes

Code	Frequency
Process integration of math and language is used during hands-on learning	12
Use of nonfiction texts in reading groups is the most common form of content integration.	19
Time is needed for collaborative planning.	19
Professional development needs to be teacher-planned and teacher-implemented.	18
Effective science content integration requires specific materials	17
Hands-on learning is used to connect various areas of the curriculum.	21
Math and language skills are required for science learning to take place.	18
Special Education students and students below the age of nine have a pedagogical need for and integrated curriculum.	17
Teachers wishing to integrate use nontraditional means to acquire materials.	12
Special Education teachers use pedagogical integration to nurture content acquisition and functional skills development.	9

Appendix F: Evidence from Transcripts Related to Themes

Theme: Student population affects teacher definition of integration.

GAL1: In this reading lesson, the teacher attempts to integrate science content with reading skills as well as life functional skills. The participant states: "I think at home you have all kinds of machines and you don't realize how all the machines you have help you at home."

G1: The participant was asked if their definition differed from that of her peers. The participant responded: "It probably does. I would say that the mainstream general education teachers integrate more, to transfer skills maybe...Using something from one subject area to another. Generalization .Whereas it's more reinforcement for us. I mean, I guess it could be reinforcement for them too. For them, it's like you're using the subject matter in a totally different subject so you would have to be generalizing that skill across those areas."

M1: The participant provided a response that highlighted the pressures of testing, particularly in the area of writing. Participant: "Well, let's see. This is only the second year that I've taught science, so as far as fifth grade curriculum. This is only the second year I've taught science, so…as far as fifth grade curriculum. In North Carolina, I taught it in fourth grade. So, it's been kind of a challenge for me, I guess in just getting the content. And finding resources and everything to use with the content. But I try to use a lot of…You know, maybe integrate it more with writing after we do maybe little lab experiments we do maybe with the lab write ups. They have to be complete sentences using…I mean, using hooks. I mean, even though it's science. Just incorporating the same things we've been using for our writing for the writing test. And then also trying to incorporate the math part of it into the experiments. Definitely more content focus on writing than science. We have a longer block for writing than we do science and plus…I know this is terrible but there's more emphasis within the school and the county on writing so there's more pressure. I think the writing is more fifth grade specific. If you look at some of the other grade levels like fourth grade, where they have to pass everything, they have to find a way to allot the same amount of time for every subject. Or at least to get, they can't afford to miss…Any of the content areas at all. I think it's more fifth grade specific in general because in a lot of schools and stuff it's not the case but, especially within [the school system], they have to pass the writing test so we place more emphasis on that. I know it's terrible. But that's, unfortunately, kind of how it works out."

R1: The participant defines integration as a thematic blending of objectives, but then further explains how this definition is dependent upon the age of their students. The participant states: "Where you take a theme, and everything you do goes around that theme, and it's all intertwined, and it seems like things have changed a little bit from that and now we're doing a workshop and calling it guided reading. But I still feel like its incorporating. Like, for example, my theme this week is like groundhogs and talking about light and shadow. And so, during readers' workshop, I would read a book about light and shadow, and talk about both comprehension for the reading portion, then I'd talk about light and shadow for the science. So it's trying to get the best bang for your buck, a double-duty type of thing."

"I think it has to do with the stage of development, but within the dynamic. The majority of my class turned six, right before school started, and so their developmental stage might be different than a class that turned seven and they're almost eight at this point in the year. So, yes, it's developmental, but it's age appropriate for first grade."

Theme: Process integration is the most common form of science content integration, followed by thematic integration.

GAL2: The participant states:"Like when you go to the bathroom. You get rid of what is leftover. Yes that's leftover food. So we are filling in the blanks to these questions. Let's make sure we are all at the same place, so read number one and make sure we have filled in the correct word. Okay, number two. Good job. Okay, number three. They reproduce. Make more of their own kind. Okay, number four let's see if we've got this one. Number four. Good job. That's such a hard one to remember. Okay guys, this is something that we have to think about the answer to." In this lesson, the participant is using functional life skills and reading skills to lead students to science content knowledge.

LAL1: The participant states: "So today, listen carefully. Cause it's going to take creative thinking. Today, when you finish your T chart, when you get your conclusions, and I'm going to come around and observe you and see how you are doing…you are going to write your own version of 'Row, Row, Row Your Boat' using magnets. Okay, so you want to think about the things you should know about magnets. Okay, that north and north repel each other. That south and south repel each other. North and south, opposites attract. All those things…Think about that and see if you can think of one creative verse, cause we've been thinking about poetry in Language Arts and writing…and see if you guys can come up with a song and I will give you an alternative option if your brain is not creatively thinking with 'Row, Row, Row Your Boat', and you know another poem or song, cause a song is kind of just like a poem, if you want to do something like 'Twinkle, Twinkle Little Star'…If you want to do something like the 'Itsy Bitsy Spider' if you know the rhythm of that then you can take the words out and put words that have to do with magnetism…And magnets in there. That's the same thing they do with Bill Nye, you know? Every time they have a band get up there and sing a song…That's pretty much what they do." This is a hand-on lesson where students combine the science of magnets with writing. Prior to writing poems/songs, students have an opportunity to experiment and explore physical objects and the effects the objects have on one another.

L1: The participant provides a definition of integration that is aligned to the definition of process integration, as defined by Meyer et al. (2010, p. 155). The participant states:"When I think of integrating subject areas, it's more or less a way to focus standard-wise on a subject you're teaching per se, if you're taking a language arts standard, I want their fluency to become better. Taking something, for example, lungs. We are working on lungs in our centers, but they are working on their fluency and on their comprehension and so the thing that is not taking the advancement of not sticking to that exact standard that you are on. That you are pinpointing, but try to combine as many areas of thinking as a way to do that. Combining science in there and things like that."

M1: The participant provides a response that explains the integration of writing standards with science standards. The participant states: "Then sometimes I have it planned that way. Especially with writing, because with writing I try to incorporate the two together. Even when I did social studies. I always wanted them to use what they were learning in their writing. With every subject area, because I (a) think its more challenging for them to use that with science than just with writing, and (b) it's also practicing those concepts, even if its just a paragraph. They still have to integrate the science content with the writing content."

RAL2: The teacher is conducting a lesson on words that end with "–ight". This lesson is a thematic blending of objectives based on the scientific concept of light and shadow. The participant states: "See, somebody who has not raised their hand before…Might? Okay, so we're going to put the M in our left hand and the I-G-H-T in our right hand? Might. Clap them together. Might. One more and then we're going to be out of paper. Bright. Okay, I'm glad you thought of it. Can you use bright in a sentence? Could you use it in a sentence for me? I'm not quite understanding what you're saying. Okay. Height. Yep, height does work. Yes, it is the same sound. It does sound that way. Not called on. I haven't called on you yet. Fright. Good one. F-R-I-G-H-T. So here we go. F-R I the left hand and I-G-H-T in the right hand and then we will clap it together. Fr-, -ight, fright. Bright. So use that in a sentence for me. It has to be a real word sweetie."

Later, in the lesson, the teacher seamlessly brings in the science objective: "Today, we also have a very special kind of light. This light is much brighter than any other light. It's called a laser. You can see lasers in supermarket checkout counters. They read the pattern of lines on each label. So raise your hand if you have gone to Wal-Mart or Kroger and have gone through the self-checkout line. So, that red light that you see when you put your groceries over the light, that's a laser light. Excellent. Put your hands down. Yes. That's right. The library has one. I'm glad you're noticing these different sources of light all over the world."

Theme: The most common use of science content integration is reading exercises based on nonfiction texts.

B1: When asked if they integrate science with reading, the participant responded: "I won't use the science text, I'll use our small books that we have that go along with our curriculum. So, a big thing that we do in second grade is teaching them the nonfiction genres. So I'll pull those books aside and we'll learn the facts about it, but we'll learn the parts of a nonfiction book, at the same time, so I'm not just covering nonfiction, but they're learning the science material at the same time. Or, not so much learning it, but it's reviewing what I've already taught basically. I won't teach it through the small mini books, I will teach it through instruction during science time."

L1: While explaining their use of science content integration, the participant states: "I see myself doing this more in my reading groups. Well, right now, it's a…last week we did…we were working on…because of heat…a nonfiction article on matter. And so they read and article on matter and it had a picture of the different states of matter. And then afterwards they had a matching and fill-in-the-blank activity that they could turn in for informal…for grading assessment. And this week, they are working on a nonfiction article with lungs. They have an activity with that as well, as well as a diagram of their lungs and things like that. That doesn't particularly…as far as when you talk about the science integration you know with their body and health. And we were talking about nutrition and what keeps our lungs healthy, and they're doing all this as well as enhancing their vocabulary, which is another literacy skill that they are working on."

“So, back to back weeks, both weeks in their guided reading groups, they have done articles, nonfiction articles, directly related from science. We talked about data collection. That was one of the first nine weeks objectives. In the [objectives]. And we talked about that. I think, a lot of times, if you say data collection in kindergarten, they would have no idea what you are talking about. However, if you did a small science experiment with them, with kindergarteners, they collect data. You can teach them how to organize it in a chart. They are essentially doing it without knowing that they are doing it. So, yes and no according to how deep you go into the content knowledge of what they are doing. But yes, for the most part in the math strategies that we use, for the most part, they have to be able to find the difference in numbers and the difference in temperature as well as those science and math words.”

“And figure those things out…Decoding, because they are going to get some vocabulary words with lungs. Esophagus…You know? Those words where their diagram, their picture that I printed out for them is labeled. Helps them see…okay what does this word mean? Okay, here’s your diagram. They see where it plays a role in how their body functions but it also helps with their decoding and their phonemic awareness. Their words and how the letters sound and putting those words together for my low readers. And it’s excellent for my low readers gaining that self confidence. For bigger words and things like that. Because when they see the picture of the lungs, and they are thinking about that, in an ordinary book, if they see a word like that, they are probably going to pass it, give up on it, or not give it an attempt. This is their connection, this is their body. They have lungs in their body…This is something that they carry around…And esophagus…You know…So, it’s something that they are connected to and they can relate to…And if they can relate to it, they are going to make a connection and they are going to remember that."

L2: The participant responds to an interview question with a comment that describes science content integrated with reading, but also shows the importance of teacher collaboration. The participant states:"Okay. I guess the biggest where I can really make that connection is through our chats. On my grad school on my masters degree. We get on and we do chats about those common topics and integration, and I think for the majority of it, the way they integrate is through…To integrate things through reading, it's become a big topic through nonfiction reading instead of fictional reading to integrate any subject area, that's been number one. Because when you're doing guided reading, and we've talked about the research behind guided reading, and collaborative learning among different students, what's been proven effective is that these students read nonfiction readings, that are level appropriate, and they can integrate those subject areas while working on their reading skills. And comprehension skills. And that's been rally number one how it has been hit. The big change, rather than getting a fiction book, getting a nonfiction book and focusing on elements in reading, and in writing as well."

RAL1: The teacher conducts a reading lesson using a book about shadows. Then, the students have a hands-on activity where they create shadows. The participant states: "Okay, so today boys and girls, today we are going to be talking about what good readers do when they read. We've been talking a lot about what good readers do so far this year. Good readers make text to text connections. And good readers make text to self connections, and good readers make text to world connections. And good readers visualize and get mental pictures while they read. We're going to start talking today about another new comprehension strategy and it's another thing that good readers do when they read. And it's asking questions."

GAL1: This entire lesson consisted of students using a nonfiction text based on simple machines. Over the course of the lesson, students related simple machines and their use to their lives.

BAL1: "Today, we are going to continue our unit with forces and motion. And the one thing that we're going to talk about today is motion, and this book does a good job explaining motion, and it's also going to talk about the laws of motion and that's why you see our chart right here. This is a review of what this book is going to talk about. So, this is 'Simply Science: Motion'."

Theme: Most science-based hands-on activities usually involve an integration of math and/or language arts.

B1: When asked if they believed that there was a connection between hands-on learning and content integration, the participant responded: “Yes. Because a lot of what we’re doing in math and science, we’ll do hands-on things, like any of our activities that we’re supposed to be doing, they’ll actually be doing the measuring, and they’ll be weighing different things, finding out the masses of different things. So they’re physically able to do that. I don’t show them the answer in the book and have them feel like that’s how they learned it. They actually do it themselves, and so a lot of the math is related to the science as well.”

RAL 1: The participant states: “Good readers ask questions after the story is over. So, now that the story is over, I’m thinking about the end, and it says that the sun was in a different part of the sky, so it made it easier for bear to keep his deal. I’m wondering, why and what does it matter where the sun is, to make a shadow in a different place. What’s the connection between where the sun is, the position of the sun, and where you shadow is. We’re going to go outside to explore that question. We’re going to go to the back parking lot, and we’re going to get with a partner, and we’re going to outline each other’s shadow. Raise your hand if you know what outline means.” The students are tracing their shadows with chalk in the parking lot after reading a book about shadows.

R1: The participant explains the use of hands-on learning with thematic teaching. The participant states: “Well, when I taught money we brought in about about how you could use vinegar to get the copper, the oxidation, how pennies turn brown because of the oxidation. And we put them in vinegar to clean the pennies. And so here we were studying how to count pennies in math and I could bring in the science, to show them how science works with everything."

BAL1: This lesson involved students bouncing balls and recording results, followed by writted summaries. The participant states: "So. So you're going to fill the sheet out. Now, what do you notice about this sheet? Is there a place for your name? No. Are you supposed to put your name on it? Yes. Is there a place for you to put what kind of ball you were using? But do you think that's important? Yes. So once you get started, you and your partner are going to get one of the balls. One time, one person will come up and get a ball, and the next time your partner will come up and get a ball. Okay? You get to do it and you get to try three different things with that ball, before you get a new ball. Now, count how many space you have. One, two, three, four, five, six, seven. Do you think that seven if enough? What could you do? Turn it over and start on the back. Make your own chart! Draw a line down the middle. Make a T chart and then you can do some more…if you have time. Now you're going to want to bear down on your folder."

L1: When asked about their use of science content integration, the participant makes a statement related to their use of hands-on learning activities. The participant states: "On most all my science experiments that we do biweekly they involve…the first thing is their charts they do on their science experiments and their numbers. They're data thinking. Collecting data and manipulating data in some way. You know we just, we just got finished with heat. Had a huge deal with the numbers and the computation. You know what I'm trying to say…The adding and subtracting of heat. What would be the effect over a long period of time? Having all those math skills that we're working on in number computation and data collection. All those are math standards that I try to adhere to in science. It's there. Just by doing a science experiment and teaching them how to collect data in the form of a chart. You know, so all the rest of it kind of falls into place, with what they are doing."

M1: The participant makes a statement that reveals the use of science to interest and motivate students in other areas of the curriculum. The participant states: "Obviously if you're using measurement in math and using it also in science, they're probably going to get more out of the measurement in the science activity, than the math activity, just because they are using it hands-on. Even if you used it hands-on in math, you see the same exact thing when you use it in a different subject. Just like writing. When I put their writing into social studies and now science, I feel like they kind of, especially if it's something they are interested in, they do it and they aren't complaining about it like they are in writing class. If they're…I do feel like, that I get more out of their writing sometimes, if they're…They get tired of writing in the context of just writing. Like sometimes its exciting to them to use it in another avenue. And not view it as just a writing lesson. When it's in a different…Different subject."

Theme: The lack suitable materials is an impediment to science content integration.

B1: The participant comments on how they obtained science materials through a nontraditional means. The participant states: “No. We first didn’t have a lot of books that were nonfiction books in our classrooms. And fortunately, going through all the different science adoptions, I’ve been able to get a great library of science books and I’ve been able to use them. I did two different series of the science adoptions. And both times that had nonfiction books available to use at the same time and the schools got to keep those books. This was the last two adoptions and we haven’t gotten a book since then. We haven’t ever gotten a book that we’ve voted on as a county. In the schools yet, but we were able to keep those extra books here. Since I was one of the ones that got to go, I’ve got amazing books.”

G1: “Mostly for us, if we’re combining math and reading, it would be more like in reading problems. And teaching key words, and teaching new key words, like in multiplication or whatever, and combining, actually reading the problems. Because word problems are difficult for them, especially reading the word problems. Because they might have names in them, and it depends on where we get the problems. A lot of times, I will type them up myself, and I will use the students own names in the problems. Cause they like that. We make a lot of our own materials. It’s hard for us to find materials. It’s hard for us to find materials from other curriculum books and things that really fit our kids. So we use a lot of their own names. And we use the things that they like. Like toys and stuff. Like, ‘Jason went to the grocery store, and’ it will have a picture of something Jason likes. I think it’s better for them. Because, just like making up those word problems, it's better for them. It's better for them and I think it engages them a bit more. And it's better for them, in what we're doing to have their own names in there. So, that's one reason we make up our own materials, to engage our kids a little bit. It takes more to engage them, I should say…And keep their interest in learning these things, so we have to make it interesting, I should say…"

G1: When asked about supporting teaching with science materials, the participant responded: "We haven't had the materials available to us. But even if we had the materials available, that really goes to word meaning and I don't think that our kids need to work on word meaning as much. As the actual spelling."

M1: When asked about the availability of resources necessary to teach and/or integrate science the participant responds: : "I wouldn't say that, no. I mean there's a lot of resources available here. I would like to see more science resources. Even textbooks. I don't like to use textbooks a lot, but it's nice to have them as a reference, since we don't…The ones we have we don't…Each class doesn't have a class set so a lot of times there are a lot of good things to reference but we don't have those. And it would be nice to have them."

"I think we could…Like with these experiment boxes and stuff. A lot of the stuff is outdated and it's not that I mind to go out and buy the stuff but it gets a little pricey when you're trying to do all of these experiments. Even though you want to do them. So I would say that we could use some more updated ones, that's for sure."

M1: The lack of materials prevents teachers from integrating science content more effectively. The participant states: "I think so because you know we have these little…These little books and I'm not saying that I have to have the books, but it helps me just to read it and figure out the information myself, but I don't have any resources to go with them and every teacher has a set, which means I have to figure out which set I'm supposed to be using, and then usually they are using them, so I have to wait to use them. You know, it's just one of those things where I would like my own set of materials."

Theme: Teachers feel that they could provide higher-quality science content integration if they had additional time for planning and collaboration.

B2: "Honestly, I personally think that if our day was an hour longer, we would be able to maximize what the kids need to learn. Because for me to teach everything I need to teach to these children, an extra hour of the day would be ideal. Do I think that's going to happen? Probably not, but that would be my ideal world to integrate it."

G1: "It would always be nice, but we don't get a planning period. We could arrange it, but like sometimes I just have three or kids in here, but they're on such different levels. And every year it's a different bunch of kids and they're still on different levels, and so you're constantly trying to reinvent the wheel sometimes."

G2: When asked what would help them to reach their students better, the participant responded: : "One thing that would help us, I think, is, well number one, we never know for sure what grades we're going to have. For example, this year, I've got three grades, whereas one year, I only had third graders. So, now that they've had us following the AKS and trying to keep up with that we're just barely staying with it a step at a time, if you understand what I mean by that, and that's staying ahead of the game, a little bit. And it will be better for me next year if we have second graders because I've already been able to see what they're doing, and, like it's my second year really trying to follow it in third or fourth grade. But if we could spend some time on what the general education class is going to be doing, over a nine week period, say if it was with you or somebody, and kind of target the topics that are going to be covered, and you could help us break it down into components so that we could target what would be most important for our kids. You know, because we haven't taught that general education curriculum and we can see the AKS listed, but if we have not been a general education teacher teaching that curriculum, we're just not that knowledgeable about it. We can get the books, but it's just time consuming when you have multiple grade levels that you're trying to get that information for."

G2: "The problem that I have with some of this is, well, I have a couple of problems with it, is, is learning this and spending so much time on it really helping my kids? To learn what they need to learn for their future lives? But then I know that it's important to them to have the same opportunity as any other kid to have the same opportunity to be exposed to that. Because we're not doing them a service if we are not opening them up to as many things as we can that they can learn. Because I have seen what my kids have been able to pick up on and they like it and they are interested in it. So I don't know if it would even be practical to have it in one, one set of standards for all grades. This has taken some time for special ed teachers to really get a handle on. Because, before this started we were responsible for our IEP goals and objectives alone. That was it. And we did not have to teach science and social studies because it was not on the IEP's. Most of us chose to, and when we did it that way, even if we had two grades in our class, we would pick topics and we all did the same thing. Kind of what you're talking about. But then when they changed things and said you're responsible for teaching your kids the grade-level AKS, that put us in a whole new picture here because we had to figure out what the grade levels were doing, number one, and then learn it ourselves and make sure we knew it, and figure out how to teach it to the kids when you have two or three grades. And it takes a while to do that when you're not used to doing that, so it's been a process. And I feel for new teachers who are out there trying to do that, because it's not the easiest thing in the world to do." The participant then went on to explain how regular education teachers could benefit from special education teachers: "There might be some things that they could learn from us, because we do approach some things differently. And it depends on what the kids are like in their class and what their needs would be. Cause I know that the kids in my class are lower than any of the kids that they would get. But still we have some techniques that we use. Just for example**,** I went into a third grade class one morning to see a child that I had gotten to know, and I was helping, not mentoring, just helping him. And his morning word was a sheet with three-digit subtraction with regrouping. And the child could not do any of them. And he's coming here, sitting at this paper, looking, and I'm thinking why does he have this? He can't do this. But yet, if he had had a sheet of Touch Math…If he had had that or had been taught that, and I found out later that he had been using touch math in resource, but there was not the connection there in the regular class. But if was using the touch math, he could be sitting there doing what the other kids were doing and he could have been successful. So, it's using those techniques that we might use in here, that the regular ed teacher could use in her room for specific needs that regular ed kids might have…"

M1: When asked about their personal time available for professional development courses, the participant provides a response that reinforces the need for collaboration for effective science content integration. The participant responds:"Well, when I was in North Carolina there were a lot of really good workshops and stuff. And I went to those and got some really cool activities to do…A lot of…Cause we…A lot of hands-on…A lot of movement…And here I know there's a lot of workshops we can go to but, I feel like we're having to take on so much as it is, it's difficult sometimes to find the time to just go and do these things."

"Well, for instance, if they are on the weekends. You know, if it's a Saturday. And, you know, you're just tired. You have things you have to do at your own house. You're trying to get caught up on stuff. It would be nice if they could bring them, you know, during a time when we're already working, or directly right after school. As opposed to having…And plus, I live further away, so it takes me a while to get here or anywhere around here. So, it's just one of those type…"

"I feel like a lot of our planning time is…Like right now, it's kind of died down, but there was a time not too long ago where it was like so…One thing after another it felt like…I don't feel like we have enough time to collaborate, like with everything we have to do, like getting ready for SST's, and IEP's, Academic Contracts, you know, I would like more time to do that because I know like, you know like, [a fellow teacher] I would love to get some of her ideas and to be able to sit down with her and I think that [a fellow teacher] has a lot of things."

L2: The participant elicits a comment that underscores the need for collaboration. The participant states: "Well. Obviously how I team teach with [name of fellow teacher] she would integrate social studies. Through her nonfiction readings, because she teaches my class and her class social studies. As far as a different way of integration, I don't know. Not being able to go into their classroom and not being able to see their style, other than their collaboration between what we're teaching. How we administer it, and the integration of it. That, I don't know…I don't know a lot about how they would integrate it. Just my colleagues on my grade level around me."

R1: When asked about group planning and the impact that collaboration has had on their grade level, the participant responds: "It's kind of a thing, where I and a colleague went to the math and science staff development that was offered by the district, and then we came back and shared what we learned, in grade level planning, and the other members of our grade level liked it. And so we all have our own personal quirks, and some of those things don't even happen, until you're up in front of the class and the idea just hits you, and so some of it's just our own, and some of it is planning. And we do have grade level planning every Thursday, and we have pods, and there's eight of us, so it's two two-two-two, And we will work together. And that's a lot of sharing materials, and that's something that has a lot to do with that as well."

The participant then explains why teacher-led collaboration is most beneficial: "They offer, and I guess for the last three years. They've offered a science class where you can go once per month, and I participated in that last year and was so impressed with it, because it was a first grade teacher, which is what I teach, following [the system standards], so I could go and then I could plan for the next unit. And so it was aligned to our curriculum map, as well as just being there, just information, and I liked how they gave you're a grade level below, so you knew what the kids should have been exposed to, and if they hadn't been, you knew what to do, and you knew what was expected for our grade level and the grade level above. So we could fit our lessons in, without stepping on the toes of the next grade level, but still making sure we filled in the gaps from the grade level below.

"And I liked the integration parts. When they talked about a particular topic, they gave examples about how you could apply it. How you could do a math lesson with that particular content, and a reading lesson, and then the language arts lesson, and a grammar lesson and that kind of stuff, and that was really beneficial…”

L2: When asked about what would help them grow as an effective practitioner of science content integration, the participant replied: “I think teachers planning together. Sitting down, thinking creatively of a lesson, taking the time out to think of a concept from a standard that type want to do. And putting those other content areas in place with theat. obviously, the teachers that teach the staff development, they do that as a group, and they have asked me before to do that, to teach that staff development. But they sit down. They’ve sat down as a group; they come up with their lesson plans, and share them with each other. And they are shared with a few people. But I think, I think it’s the creative thinking that’s looked at, that that’s what they are there to do, so they know it needs to be effective and the integration of it, and the way that they do it. But the best ideas from me came from actually doing it myself. Going in the classroom and being able to do it. And teachers don’t get the time to do that. It’s just. It’s really…I mean you walk through science experiments…You walk through with your head…okay…I’m going do this, I’m going to do this and I’m going to do this…Okay…That’s how it’s going to work. But then actually do it and to be in the position of the students and to think like the students and to go through it like the student, that’s where the creative thinking comes out, and you can really come up with some good ideas. And I really think that’s why it came across to me so well.”

The researcher then asked why the participant felt that there was not more of the described collaboration occurring. The participant responded: “Priorities. Where are the priorities of the people that tell us what to do? Where are the priorities of the people around you? Because obviously you can't force mutual planning on people around you that are…You know, have other things and they don't consider that a priority. You know, course load among what they have to do. But you know, I think it directly involves where your priorities are about what you are expected to do. If it's provided for you…If it's never provided for you as a teacher…as a classroom teacher, then it's never provided or set aside or modeled, or given as an option, it's never going to be there. As a new teacher coming in, if you have no idea about, you should know about integration, but if you've never effectively figured out how to integrate things and if it's never modeled for you and you're never given the option to do it and you're never given any examples to do it, you're probably never going to do it. So just the modeling and the belief that it can actually be successful cause if you don't believe in something, it's not probably going to get passed down. Or time is not going to be provided for it."

Curriculum Vitae

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EDUCATION

Walden University
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McKendree Elementary School, Lawrenceville, GA
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