A DESCRIPTIVE CASE STUDY OF A SUBURBAN NORTH CAROLINA SCHOOL SYSTEM’S DEVELOPMENT AND IMPLEMENTATION OF ELEMENTARY SCHOOL SCIENCE CURRICULUM

Tony Michael Srithai

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of doctorate in educational leadership in the School of Education.

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Approved by:
Eric Houck
Janice Anderson
Victoria Creamer
Brian Gibbs
Lauren Sartain
ABSTRACT

Tony Michael Srithai: A Descriptive Case Study of a Suburban North Carolina School System’s Development and Implementation of Elementary School Science Curriculum (Under the direction of Dr. Eric A. Houck)

For decades, education policy has prioritized the need to improve reading and math achievement while science teaching and learning have received far less emphasis. In 2013, schools across the United States began implementing Next Generation Science Standards (or similarly structured, state-adopted science standards). These new science standards required schools and teachers to undertake different approaches to improve the teaching of science and science practices. However, relatively little research has been conducted regarding the strategies used by individual school districts to ensure that students receive rigorous science instruction consistent with these standards.

In this dissertation, I conduct a deep case study in a suburban public school district in North Carolina to explore the development and implementation of a new elementary science curriculum that focused on the use of science kits. Using a wide range of primary documents, including historical documents and financial data, I created a descriptive timeline of the curriculum development process. Systems theory was utilized as the research lens to produce a narrative that accompanies my document analysis. I sought to identify revenue sources that fund the design and implementation of elementary science curricula, how these funds are expended (particularly through the deployment of science kits), and what factors influence these curriculum considerations.
I found that the district’s curriculum work resulted in a more aligned elementary science curriculum. This common scope and sequence supported district streamlining of cross-curricular elementary experience. Reading, math, and other subject areas could be easily integrated into a shared curriculum common to 11 elementary schools. Assessment tools could then be used to better inform the further refinement of curriculum and instruction. Two schools were resistant to the initiative, leaving them somewhat misaligned with the district-wide curriculum. Schools that most successfully implemented the curriculum demonstrated consistent collaboration between teachers, staff, and administrators; were provided timely professional development in the curriculum development process; and benefited from the oversight of a district Science Coordinator. Taken together, other districts that are overhauling science curricula should ensure that schools (a) maintain a focus on strong and backward-designed curricula, (b) support teachers in the planning process with professional development, and (c) offer flexible leadership in the curriculum design process.
This dissertation is dedicated to my family.

Mom, you taught me how to work hard and see things through to the end. I am proud to be your son and to have worked toward this degree.

Charlotte, you gave me the most amazing gifts: Patrick, Isaac, and Jacob. You are an amazing mother and have supported me and our family through these years of hard work. Thank you.

I love you always.

Patrick, Isaac, and Jacob, you make me proud each and every day. You are so loved by so many.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ELA</td>
<td>English language arts</td>
</tr>
<tr>
<td>CHCCSD</td>
<td>Chapel Hill-Carrboro City School District</td>
</tr>
<tr>
<td>CCSS</td>
<td>Common Core State Standards</td>
</tr>
<tr>
<td>PLC</td>
<td>Professional Learning Community</td>
</tr>
<tr>
<td>RttT</td>
<td>Race to the Top</td>
</tr>
<tr>
<td>STEM</td>
<td>Science Technology, Engineering, and Mathematics</td>
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<tr>
<td>IFL</td>
<td>Institute for Learning</td>
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CHAPTER 1: INTRODUCTION

With over 2 decades of standards-based educational data, much research has been done to examine the impacts of accountability policies on student achievement. Although many other policies have been researched, one example of longitudinal data analysis by Carnoy and Loeb (2002) reported greater student gains in states with high-accountability, standards-based testing systems. A study by Copp (2016) related “teaching to the test” (p. 1) to the presence of high-stakes exit assessments and the amount of pressure teachers perceived from the testing process. However, student gains are at times inequitable across racial/ethnic and socioeconomic strata (Hanushek & Raymond, 2005; Reardon & Portilla, 2016). Additionally, research has examined the role of teacher-led, classroom-based instruction. Research-based teaching practices have proven effective in promoting student academic gains (Thompson, 2015). This research, however, focused primarily on pedagogy while overlooking curriculum.

The Chapel Hill-Carrboro City school district (CHCCSD) is a resource-rich district where per-pupil spending was $7,482 in the 2015–2016 school year (National Center for Educational Statistics, 2017) relative to $5,285 averaged across the state and $12,248 nationally. The district spends an average of $100,000,000 annually on instructional services, which include teacher salaries and benefits, instructional resources and materials, and science kits (approximately 70% of total expenditures). These services impact all aspects of teaching and learning in Grades PreK–12 for the district’s roughly 12,000 students. In this study, I examined the district allocated funds to support the development of new elementary science curriculum and
explored the revenue sources that fund these initiatives. I also uncovered the guiding principles that influenced the district’s curriculum design via the analysis of historical records and documents (e.g. meeting agendas and notes, emails, etc.). The newly designed elementary science curriculum was implemented in 2016 with a plan for further refinement of district-created, hands-on materials.

This rich case study of CHCCSD’s elementary science curriculum illuminated facilitators of and barriers to implementation. This study is particularly important because curricula in the United States have historically gone unevaluated in terms of the planning process, delivery of instruction, and translation into student mastery of standards. Nationally, district-level fiscal data are collected so that the U.S. government may receive reports concerning the condition of American education. This study was designed to analyze the relationship between educational standards, school district expenditures, and curriculum design and implementation.

The first chapter of this dissertation presents background information about curriculum, how it is conceptualized, and issues typically associated with curriculum research, as represented in schools and school districts across the United States. The background includes an overview of the impact of curriculum and curriculum implementation on education. The chapter also details the context of the study, the reason for the study, the research questions, and the methodology. Limitations of the study will also be presented, and a brief summary concludes the chapter.

**Background Information: What Research Says About Curriculum**

This section will detail curriculum and the ways in which it is conceptualized. It will define curriculum and how teachers and researchers currently view associated concepts, definitions, and measures. In particular, I examine a broad range of research that supports varied operational definitions of curriculum. Curriculum funding, development, and implementation can
be difficult to research without also including the many internal and external factors impacting the decision-making process of a school district. In short, what is curriculum?

Over the years, researchers have expanded how curriculum is defined. Curriculum is often described as having three parts: the content and skills students should master, the sequence in which those things should be taught, and instructional materials that facilitate the learning process (Van Heukelum, 2014). First, Walker (2003) broadly defined curriculum as “a particular way of ordering content and purposes for teaching and learning in schools” (p. 4), which has subsequently been cited in practical guides for teachers (Hedgecock & Ferris, 2013; Seifert, 2019) and curriculum design research (Voogt et al., 2011). Whitehurst (2009) added to this definition by stating that curriculum should also include teaching materials and pedagogy for delivering those materials when recommendations for delivery are provided to teachers. English and Steffy (2001) expanded the term further to include assessment and evaluation in a manner that triangulates the intended curriculum, taught curriculum, and assessed curriculum.

**Why Does Curriculum Matter?**

Since the release of A Nation at Risk (National Commission on Excellence in Education, 1983), concerns about educational quality have led to standards-based reform efforts in K–12 education (Polikoff, 2010). Standards often take the form of learning targets with the goal of modified classroom instruction in order to meet the demands of standards and standardized (standards-based) assessments. Improved student learning outcomes are the ultimate goal (Clune, 1994), as historical research has attributed many of A Nation at Risk’s concerns to a poor or nonexistent curriculum in U.S. schools (Baker, 1993).

Content-specific instruction has been classified as highly supportive of student academic gains (Byun et al., 2015). Instructional practices have been proven statistically nonsignificant
when standards-based, content-alike classes have been compared (Gamoran et al., 1997). Moreover, the negative impacts of poor curriculum articulation, specifically in fields such as science and math, have been proposed as significant threats to meeting the nation’s future scientific and technological needs (Oakes, 1990). Collaboration around curriculum within school districts, schools, and academic departments has also been cited as a productive vehicle for continuous program renewal (Briggs, 2007). Briggs (2007) attributed increased instructional rigor, student assessment outcomes, and program improvement to explicit planning and delivery of content-specific curricula. A historic, political view of curriculum is also under analysis, as Subedi (2013) advocated for decolonizing political lenses in building a global curriculum.

Previously, curricular decisions and the content of teacher lessons were left to teacher-based autonomy in unit and lesson planning (den Brok et al., 2004). School districts have begun implementing common curricula (Allen & Hunsaker, 2016) in response to standards-based reform and its focus on conceptual understanding and knowledge attainment through pedagogy aligned to real-world problems (Kibler et al., 2014). Standards-aligned curriculum (and thus, instruction) continues to be the driving force behind school and student accountability efforts.

**The Problem**

Steiner et al. (2017) identified several issues associated with curriculum research, the first of which acknowledges that curriculum encompasses a wide spectrum of definitions. At the more conservative end of the spectrum, curriculum refers to the formal materials provided by a state, district, and/or school for a teacher to deliver to students. A further definition regards curriculum as everything that a teacher actually teaches. This vague definition would make it impossible to account for the thousands of unscripted interactions that teachers have with students. Curriculum and its impact will be further explored in Chapter 2.
Furthermore, research on curriculum effect has done little to define what makes curricula effective or ineffective (Stringfield et al., 2000). This gap in the research is further complicated by questions around fidelity of implementation. Stringfield et al. (2000) were not able to isolate the impact of (a) having a defined curriculum in place, (b) the level of specificity of the curriculum, or (c) fidelity of implementation of the defined curriculum, as these components are so intertwined. Focus group interviews, classroom observations, and teacher interviews seek to understand what content is taught, what assessments are used, and whether recommended teaching strategies are deployed (Steiner, 2017). However, there is no research standard for measuring fidelity of implementation.

The locus of control and decision-making process around curriculum has shifted from a classroom-centered to a policymaker-centered model over the past 30 years (O’Day & Smith, 2019). Although standards (and standards-based assessment) do not define curriculum, they do influence curricular decisions at the district level. These changes have pressured districts to take a closer look at curriculum implementation and invest in appropriately aligned curricula that support demanding standards. Measuring the financial investment in and return on investment of these materials is difficult in the absence of consistent fiscal accountability of school district expenditures across schools (Guthrie et al., 2007; Munley & Harris, 2010).

Because instructional delivery in American classrooms has changed dramatically in recent decades, school districts may need to study the impact of who selects and develops curriculum. District leaders will need to adapt their efforts to design and implement curriculum to provide ideal learning across all schools in a fiscally responsible and equitable manner. This work will need to align with state standards and ultimately align with school and classroom implementation.
Moreover, the school-based distribution of curricular materials, from an intradistrict resource allocation perspective, is often difficult to examine (Baker, 2003; Goertz, 1997). Goertz and Stiefel (1998) found organizational considerations, rather than economic or political considerations, were more significant in determining a district’s allocation of resources. The many factors that have been researched as influencing resource allocation include the distribution of human capital resources, as well as internal and external factors (Peyser & Costrell, 2004). Internal factors include district policies and corresponding accountability measures, whereas external factors may include obligations or mandates from the state or federal government (e.g., Title I revenue). As accountability policies have focused public attention on school-level performance and student achievement, how resources are allocated to schools at the state- and school-district level, as well as how districts’ schools use funding to support teaching and learning, has gained increased attention (Houck, 2010). The hope is that school systems are spending money on the resources most likely to benefit students. Thus, this dissertation investigated the allocation of resources to developing and implementing new science curriculum.

**Conceptual and Theoretical Framework**

The conceptual and theoretical framework of this study was based on a general systems theory model and lens. Wilby (2006) described this as an approach to analyzing sociocultural systems and their impact on overall system structures. In particular, social organizations (and members of those organizations) consist of “roles tied together with channels of communication (Wilby, 2006, p. 698). This framework offers a way to analyze the many factors (e.g., funding and district initiatives) impacting curriculum design and explain how structural systems drive implementation. In using this lens, this study sought to provide recommendations for policy
proposals and support for administrators and school leaders when making curricular decisions. The theoretical framework is further explained in Chapter 2.

**Context of the Study**

This section describes the researched school district, including size, organizational structure, and policies governing both curriculum development and instructional spending. Background information is provided regarding elementary science kits and a Science Coordinator’s role in refining their implementation over a 2-year span.

In the 2015–2016 school year, the CHCCSD served approximately 12,100 students in the Chapel Hill and Carrboro townships located in Orange County, North Carolina. That same year, it was the 32nd largest school district of the state’s 115 districts (excluding charter and independent school organizations). Student enrollment maintained steady growth in the 2 decades prior. The district was then and is still comprised of 11 elementary schools, four middle schools, three comprehensive high schools, an alternative high school, and a hospital school located within the North Carolina Children’s Hospital (located in Chapel Hill, North Carolina). My administrative role within the district allowed me to gain specific insight into the curriculum development process, and my interest in the success of the elementary science curriculum led me to choose the district for this case study.

The Chapel Hill-Carrboro City Board of Education is a separate government entity that provides public PreK–12 education to students of the district. The district receives funding from the state and federal governments and must comply with all legal requirements of these funding sources. The State of North Carolina grants control and supervision of all matters pertaining to the district and schools to the publicly elected members of the Board of Education, consisting of
seven members elected to staggered, 4-year terms. Both the Board Chair and Vice Chair are elected by the Board, and the Superintendent of the CHCCSD serves as secretary to the Board.

In addition to the Superintendent’s office, the CHCCSD operates three organizational divisions within its central office. The Information Technology Division coordinates the planning and deployment of technology initiatives, and the Support Services Division coordinates noninstructional services ranging from facilities management to transportation. The district’s largest division (based solely on the number of central office administrators and staff) is the Instructional Services Division, which oversees all facets of teaching and learning in Grades PreK–12.

Revising the Elementary Science Curriculum

In the summer of 2012, the newly appointed superintendent of the CHCCSD, Dr. Thomas Forcella, unveiled the district’s strategic plan as a foundation for decision-making in the district’s schools through 2018. The first goal outlined in the plan stated that “Instructional excellence focused on thinking and problem solving will be evident in all classrooms” (CHCCSs Long Range Plan, 2013). Under this goal, the plan listed targeted strategies for achieving the goal, including the following objectives:

- the development of a timeline for the review and writing of curriculum across Grades PreK–12;
- the inclusion of a process for curriculum development that includes participants, expectations, and oversight with regard to curriculum implementation; and
- the implementation of a system of common assessments to be used in all academic areas and in all schools in order to monitor student progress and allow teacher teams to use the results to make adjustments to their instruction.
In 2015, 3 years after the announcement of the new strategic plan, the Instructional Services Division of the CHCCSD employed nine subject coordinators, including the district’s K–12 Science Coordinator. The subject coordinators’ primary role was to facilitate the design of a consistent, district-wide curriculum in each subject area. Also in 2015, elementary science education in the district relied heavily on standalone science kits, which included a district-wide rotation of kits across 11 elementary schools. These kits, delivered quarterly to each classroom in kindergarten through fifth grade, provided lesson plans to coincide with hands-on activities. All of the materials required to conduct these lessons were included within the kit, and the district contracted with ECA Science Kit Services to collect kits at the end of each quarter, restock consumables, replace damaged materials, and redeliver kits to the next school in a predetermined rotation.

In the pursuit of Goal 1 of the CHCCSD 2013 Long Range Plan, the district Science Coordinator was tasked with the redesign of elementary (K–5) science curricula. This work targeted the following goals:

- examine ECA science kits to determine correlation to North Carolina Science Standards, and
- establish a common timeline for implementation, such that each elementary school delivers the same content during the same quarters throughout the school year.

The Science Coordinator relied heavily on teacher surveys and science kit reviews conducted by Math/Science Specialists. One specialist was assigned to each of the district’s 11 elementary schools.
The district had conducted an elementary redesign of English language arts (ELA) and mathematics curricula in the years prior to undertaking this work in the content areas of science and social studies. As such, ELA scope and sequence documents were used as a foundational reference for the development of a science scope and sequence. For example, if a particular grade level was engaged in a unit with a focus on nonfiction texts, science units were designed to incorporate nonfiction at the appropriate reading levels and relative to the corresponding science and ELA standards. A unit on erosion might incorporate a text sample that discusses the Dust Bowl, and the corresponding writing unit, with a focus on argumentative writing, might task students with writing to elected officials regarding the impact of humans on the environment.

The Science Coordinator met with the Math/Science Specialists approximately once per month over the course of 1 year to propose a redesigned elementary science scope and sequence. In coordination with the Assistant Superintendent for Instructional Services, a proposal was solicited from ECA Science Kit Services to explore a common timeline of science kit deliveries to each elementary building. Based on the current inventory of district-owned science kits, it was determined that an additional $30,000–$50,000 would be required as a one-time cost to establish the logistical resources to implement a common kit rotation. These funds were pursued through a budget expansion request to begin the new science kit schedule in the 2016–2017 school year.

The CHCCSD was selected for this case study for three primary reasons. First, access to historical data, including correspondence, meeting agendas, and financial records, produced a robust narrative of the data. Second, the district’s use of science kits was under review during the researched time period, which allowed me to focus on a finite length of time in the curriculum design process. Last, the financial commitment to revising elementary science curricula in conjunction with the use of science kits produced meaningful longitudinal data. This included the
district’s 5-year plan for continued revision and yielded policy recommendations for practitioners.

**Study Purpose and Research Questions**

The purpose of this study was to explore the funding of curriculum development in one district in the state of North Carolina. Through the study, I hoped to contribute to a broader research base while providing recommendations regarding the use of science kits within a district’s curricula. This study reported on funds spent on curriculum articulation, analyzed historical trends within this funding model, and determined whether budgetary suggestions can be made to practitioners when planning for major standards initiatives and/or revisions. Finally, the study provides information for future curriculum development and change. These research goals are described more specifically below. Short-term financial data for the district were collected and analyzed in reference to archival documents relevant to the work of the district’s Science Coordinator.

**Research Questions**

1. What revenue sources fund the design and implementation of elementary science curriculum?
2. How are funds expended in the design and implementation of elementary science curriculum?
   a. To what extent do school districts invest in these efforts vis-à-vis science kits?
   b. How are these expenditures allocated across schools within a district?
3. What guiding principles or district goals influence the design of curriculum?
4. What longitudinal data support the implementation of curriculum?
Methodological Overview

This dissertation is a descriptive case study of the CHCCSD’s spending on and implementation of science curricular materials. To examine the allocation of fiscal resources, I relied on budgets that outlined spending on classroom instructional resources. In particular, I was interested in the funding of science kits as an instructional tool. Then, I turned to understanding the district’s planning process associated with designing the scope and sequence of these elementary resources using meeting notes, agendas, and intradistrict correspondence records through narrative compilation and memo writing. Last, I analyzed archival data to document the guiding principles or district goals that influenced the design of curriculum and determine how longitudinal data supported the implementation of curriculum.

When used in case study research, documentation is used to “corroborate and augment evidence from other sources” (Yin, 2017, p. 115). Advantages of the use of documentation include the ability to repeatedly review documents in a nonobtrusive manner. The use of the CHCCSD’s agendas, meeting minutes, and financial data is specific in the inclusion of exact names, references, and details of events such as meetings. The collected documentation also allows for flexibility in covering adjustable spans of time. These strengths of documentation allow for a more robust understanding of the physical and social environment being studied (Glesne, 2011). I hoped that a combination of qualitative and quantitative data would approximate the costs associated with implementing shifts in curriculum implementation for one school district in the state of North Carolina.

In addition to the previously mentioned data sources, I compiled evidence under the similar theme of science kit implementation. This compilation of narratives allowed me to sort evidence in a manner that determined support for themes and ideas (Yin, 2011). Primeau (2003)
recognized the influence of a researcher’s own subjectivity in the collection and interpretation of data. However, Birks et al. (2008) argued that the relationship between researcher and data in qualitative research is critical to the generation of knowledge that acknowledges the “breadth and depth of human experience” (p. 69).

The themes of curriculum, curriculum planning, and science kits (as instructional tools) were analyzed to construct a descriptive view of the data set. The information gained through this grounded theory approach discerned common patterns of practice. Grounded theory allowed me to establish a narrative and provided an explanation of curriculum design in one North Carolina school district.

The CHCCSD releases annual budget documents that detail the budget proposal process, archive district spending, and provide a comprehensive report of expenditures to the public. I obtained archival access to the records previously referenced, and these data allowed for historical comparisons across multiple years.

**Limitations**

This study was limited to the implementation of one curriculum tool in the CHCCSD from 2015 to 2017. This study did not compare other attempts to analyze curriculum expenditures or studies in other districts or states. A primary objective of curriculum development is to provide equality in standardized learning opportunities that increase student performance. This study did not explore student performance; rather, it was limited to determining if school district expenditures on curriculum development and implementation were directly related to district priorities and other standards initiatives within a given time period.

By excluding factors beyond expenditures, this study overlooked broad factors historically linked to inefficiency in public bureaucracies, such as fiscal capacity, competition,
and a myriad of factors impacting voter involvement in monitoring local agencies (Duncombe & Yinger, 1997). For example, Duncombe et al. (1997) found taxpayers in districts with high fiscal capacity (as measured by property values, income, etc.) to have less incentive to pressure district officials to be efficient.

**Significance of the Study**

Research has yielded data regarding the effects of funding on student performance (Houck, 2010). Although Hanushek (2012) argued that funding does not matter, Lafortune et al. (2018) linked reform in the “adequacy” era to sharp, sustained increases in funding that produced a large implied effect on student achievement (p. 1). There has been less research regarding school and district funding of materials and resources as they support learning (Blanchard et al., 2013). This study was designed to relate financial costs at the district level to instructional changes at the building and classroom levels. It was also designed to determine if the money spent on curriculum articulation can be quantified and tracked. Lastly, it sought to analyze school and classroom alignment with district-level curriculum development. Research recommendations were compiled regarding the equitable implementation of such curricula in school districts. Overall, this study sought to make fiscal and system recommendations to school districts seeking or planning curriculum articulation in an era of frequent changes to educational standards.

**Definitions of Terms**

- Capital: Capital has been researched and can encompass many facets (educational, economic, cultural, social, etc.). When used within a specific society, capital influences the “social space of positions and aspects of dominance and its hierarchies” (Engström & Carlhed, 2014, p. 704). Capital can thus be used
to establish a person’s position within a hierarchy and dispositions to a dominant culture.

- Common Core State Standards (CCSS): As described by Durand et al. (2016), the widely adopted CCSS provide common academic standards in supporting school-based decisions regarding instruction, curriculum, assessment, and teacher quality. Durand et al. examined implementation challenges facing district office leaders, principals, and other school leaders as a result of CCSS adoption in various states.

- Curriculum: Curriculum refers to the content and sequence of the experiences that are designed to be delivered to students in formal course work. This includes teaching materials such as those found in textbooks and software applications. According to Whitehurst (2009), “It also includes the pedagogy for delivering those materials when teachers receive guidance on how to teach the curriculum, or when software manages the pacing, prompts, and feedback that students receive as they engage with the materials” (para. 3).

- Instruction: Classroom-based teaching strategies are implemented through instruction. Instruction encompasses the day-to-day teaching and learning of academic content and skills. A Professional Learning Community (PLC) is a team of content-alike teachers that is tasked with crafting instruction (Van Heukelum, 2014). A PLC typically incorporates student experiences and a variety of learning opportunities to adhere to an established curriculum.

- Learning organization: Senge (2009) depicted his work from the perspective of a learning organization. A learning organization describes a group within an
organization that is continually enhancing its capacity to maximize influence and impact.

- **PLC**: As described by Hoaglund et al. (2014), PLCs provide the structure that must support effective collaboration among teachers. The work of a PLC is entrenched in the following questions: “What do we want each student to learn? How will we know when each student has learned it? How will we respond when a student experiences difficulty in learning?” (Hoaglund et al., 2014, p. 522). Answering these questions requires teachers to meet regularly as a team, and the accompanying collaborative skills have been recognized as critical in 21st-century teachers.

- **Race to the Top (RttT)**: In 2009, the federal RttT initiative began as a comprehensive educational reform agenda that coupled federal funding for K–12 schools with performance-based evaluations for teachers and administrators, the adoption of common standards, and the implementation of data systems in driving school-based decision making (Durand et al., 2016).

- **Salary**: Along with benefits, salaries account for the largest expenditure in any school district (“Teacher Compensation,” n.d.). These instructional expenditures include gross salaries paid to regular and part-time teachers, teacher aides, and other instructional staff within a school district (National Center for Education Statistics, 2017).

- **Standards**: Educational standards detail a body of knowledge associated with an academic area. The knowledge is established as a standard to which students are held accountable to learn. Standards can vary and are typically established at the
state level. North Carolina currently employs the CCSS in ELA and mathematics and has established state-based essential standards in all other subject areas (Van Heukelum, 2014).
CHAPTER 2: LITERATURE REVIEW

This chapter provides an overview of relevant research and literature important to the history of curriculum and instruction. As discussed in this paper, curriculum serves as the framework through which educational standards are mapped throughout an academic year, whereas instruction encompasses classroom-based strategies involved in the day-to-day teaching and learning of academic content and skills. The distinctions between curriculum and instruction will first be defined as depicted in educational research. The literature review will then detail historical perspectives on curriculum theory, development, and implementation before examining the role of school finance in curriculum. The importance and complexities of curriculum are then examined. A systems theory model is presented as the conceptual framework for the research. This chapter concludes with reflections on possible areas for future research.

Instruction Defined

Effective teaching must rely on outcome-based planning, research-based practice, differentiated instruction, and engaging students in a manner that develops automaticity with content knowledge (Van Heukelum, 2014). Anderson (1987) categorized strategic teaching and instruction through four distinct perspectives, as detailed in Table 2.1.
Table 2.1
Four Perspectives of Strategic Instruction

<table>
<thead>
<tr>
<th>Perspective</th>
<th>In other words</th>
<th>What it means to teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>The definitional problem</td>
<td>Teaching for understanding</td>
<td>What teachers will teach is based on content knowledge and what they know about how students learn.</td>
</tr>
<tr>
<td>The curricular problem</td>
<td>What is worth knowing?</td>
<td>What teachers will teach as unified concepts: what they expect students to learn.</td>
</tr>
<tr>
<td>The student learning problem</td>
<td>How does understanding develop?</td>
<td>Teachers seek strategies that best utilize students’ prior knowledge in learning new concepts.</td>
</tr>
<tr>
<td>The instructional problem</td>
<td>Helping students understand</td>
<td>Transfer of new knowledge ultimately leads to application and integration.</td>
</tr>
</tbody>
</table>

These perspectives contribute to educating lifelong learners. Establishing a learning culture requires significant motivation from district and building-level leaders. On an intellectual level, teachers must be encouraged to innovate and create curriculum. As summarized by Van Heukelum (2014), articulating a vision that is inspiring to teachers models modern curriculum, which accommodates a shift to the 21st-century skills that industry and higher education desire.

Curriculum Defined

In the mid-1800s, William Harvey Wells separated the students of Chicago into grades and determined a distinct course of study for each subject and grade level (Kelting-Gibson, 2005). In 1892, The National Education Association tasked the Committee of Ten with planning a secondary curriculum geared toward college preparation (Glenn, 2010). In more recent times, striving for a centralized curriculum model has required states and school districts to adapt to frequent changes in standards (Wiggins & McTighe, 2005). According to Walker and Soltis (as cited in Kelting-Gibson, 2005), curriculum continues to be defined as “subject naming, specifying content, and ordering the treatment” (p. 27).
Historical Context of Curriculum Development

A review of 21 sources is herein categorized. The starting point of this literature review was the era of Modern Conservatism spanning 2000–2009, which is marked by increased involvement by the federal government to increase student outcomes (eventually backed by federal grant funds), the development of CCSS, and an increase in school privatization (Glatthorn et al., 2018). To gain additional historical context, works are explored from the age of technological constructionism (1990–1999) and its standards-based movement (Glatthorn et al., 2018). The three main drivers used in distinguishing the sources were cultural, financial, and political factors. Sources were then analyzed through a historical, sequential lens to note any long-term shifts in research. At the end of this chapter, each source captured within this literature review will contribute to a summary viewed through the lens of systems theory. Findings and implications will include the following thematic groupings:

- Cultural: those findings speaking to the cultural influences upon curriculum.
- Political: historical works that connect personal disposition to curriculum articulation.
- Financial: those works connecting curriculum planning and implementation to fiscal resources.

Where appropriate, findings within these groupings will be presented chronologically in order to highlight potential trends over time.

Culture

In 1987, Anderson noted four major perspectives that influenced curriculum design and, in turn, classroom instruction. Anderson distinguished between definitional approaches (what content is familiar to teachers and what they know about how students learn) and curricular
stances (unifying concepts deemed important by the teacher). Furthermore, student learning and teacher instruction intersect when analyzing how student understanding develops and how teachers help students to understand. While Anderson promoted the importance of curriculum design, Aldridge (1989) insisted that firm adherence to a mandated curriculum prove ineffective and lead to misalignment to standards and the unfair tracking of students.

At a deeper, more content-oriented level, students’ personal views and understanding must also be incorporated in order to facilitate effective pedagogy (Songer & Linn, 1991). Aldridge’s (1992) work concluded that curriculum alignment is possible so long as vertical alignment is spiraling in nature (i.e., providing deeper exploration of key concepts as students progress through K–12 educational institutions). Herein, cultural limitations to effective curriculum implementation are noted throughout. Conversely, Wagner (2001) focused primarily on teacher mindset, claiming teachers to be risk averse by nature, often seeking the path of least resistance in curriculum mapping and delivery.

Subsequently, Jorgenson (2006) examined a broader view of school and district culture in curriculum design. According to Jorgenson, a supportive culture must be in place to support curriculum design, which is a time-intensive process. To further complicate matters, Miller (2011) referenced different teacher approaches in drafting curricula. Beyond individual teacher differences, the taught curriculum can also be heavily influenced by societal values (Engström & Carlhed, 2014). Herein, much emphasis is currently placed on preparing students to be “college and career ready” (Barnes & Slate, 2013, p. 1). However, the current approach is often overly focused on college readiness while ignoring diversity within student populations (Walker, 2017).

Both researchers and policymakers have analyzed standards-based policies and their effects on academic achievement (Polikoff, 2010). However, less research has been focused on
instruction and student exposure to core content, as defined in curriculum frameworks. Polikoff (2010) contended that variability in standards implementation stems from differences in teacher instruction. Those differences are attributed to the complexities of state policies, which are influenced by “specificity, stability, consistency, power, and authority” (Polikoff, 2010, p. 10). Research must delve deeper into the ways policies affect teachers’ dispositions about what and how to teach. Table 2.2 summarizes notable cultural studies in curriculum design and implementation.

Table 2.2

Cultural Studies in Curriculum Design and Implementation – At a Glance

<table>
<thead>
<tr>
<th>Study</th>
<th>Researcher/author(s)</th>
<th>Date</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic thinking in science</td>
<td>Anderson</td>
<td>1987</td>
<td>Four perspectives in teaching: definitional, curricular, student learning, and instruction</td>
</tr>
<tr>
<td>Essential changes in secondary science</td>
<td>Aldridge</td>
<td>1989</td>
<td>Curriculum design proves ineffective and leads to misalignment and the unfair tracking of students</td>
</tr>
<tr>
<td>Student views of science education</td>
<td>Songer &amp; Linn</td>
<td>1991</td>
<td>Curriculum must integrate student understanding and personal views</td>
</tr>
<tr>
<td>Synthesis for improving science education</td>
<td>Aldridge</td>
<td>1992</td>
<td>Curriculum should be spiraling in nature</td>
</tr>
<tr>
<td>Action theory in school change</td>
<td>Wagner</td>
<td>2001</td>
<td>Teachers are risk averse by nature</td>
</tr>
<tr>
<td>Why curriculum change is difficult</td>
<td>Jorgenson</td>
<td>2006</td>
<td>Curriculum change requires time and a shift in culture</td>
</tr>
<tr>
<td>Instruction under standards-based reform</td>
<td>Polikoff</td>
<td>2010</td>
<td>Instruction varies relative to the complexities of state policies and policymakers</td>
</tr>
<tr>
<td>Curriculum styles</td>
<td>Miller</td>
<td>2011</td>
<td>Teachers have different styles in drafting curriculum</td>
</tr>
<tr>
<td>College readiness</td>
<td>Barnes &amp; Slate</td>
<td>2013</td>
<td>Current emphasis on college/career readiness is one-size-fits-all approach and overly focused on college</td>
</tr>
<tr>
<td>Cultural capital in curriculum development</td>
<td>Engström &amp; Carlhed</td>
<td>2014</td>
<td>Social/cultural capital (shared values and history among a group of people) influences what is taught</td>
</tr>
</tbody>
</table>
Many issues within education spark heated political debate. Petrina (2004) studied the balance of science curriculum and politics, and expressed that curriculum design must deconstruct the theories behind “what should be learned” and “how should it be organized for teaching?” (p. 81), as relating the two is often a delicate balancing act. Briggs (2007) referenced political climate and the importance of political support of communities of practice within a school. Curriculum planning is acknowledged as a key component of school improvement and teacher professional growth so long as it exists within a politically supportive climate. This collaborative work falls within the realm of responsibilities of the classroom teacher (Garcia, 2011). The reform process requires teacher competency in cultural, political, societal, and ethical spheres of influence. When larger political factors are at play (as in the development of CCSS), district administrators must serve as a bridge, broker, and buffer to facilitate organizational learning and improvement (Durand et al., 2016).

As an example, science education is often caught in political crosshairs. From Earth’s orbiting of the sun to Darwin’s theories on evolution, political influence is often at odds with science curriculum. Current research targets the disconnect between political opinion on global climate change and environmental education (Chapman, 2011). A historic, political view of curriculum is also under analysis, as Subedi (2013) advocated for decolonizing political lenses in building a global curriculum.

Polikoff’s (2012) research into state policies under standards-based reform highlighted significant variability in implementation. Policy attributes (and differences therein) directly impact teachers’ instructional responses. Polikoff attempted to align state policy with instructional practices. Several small-to-moderate relationships were found using statistical
models, but the study failed to support any causal relationship between policy and instructional alignment. As a final limitation, Polikoff also highlighted the statistical approach’s failure to assess the quality of teacher instruction. Table 2.3 summarizes notable studies related to the politics of curriculum design and implementation.

Table 2.3

*Studies in the Politics of Curriculum Design and Implementation*

<table>
<thead>
<tr>
<th>Study</th>
<th>Researcher/author(s)</th>
<th>Date</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Politics of curriculum and instructional design</td>
<td>Petrina</td>
<td>2004</td>
<td>Curriculum design must deconstruct and relate: “what should be learned?” and “How should it be organized for learning?”</td>
</tr>
<tr>
<td>Communities of practice in curriculum implementation</td>
<td>Briggs</td>
<td>2007</td>
<td>Political climate must be supportive of collaboration through enculturation, freedom and support to experiment, and examples and inspiration towards curriculum excellence</td>
</tr>
<tr>
<td>Science curriculum reform as socioculturally anchored</td>
<td>García</td>
<td>2011</td>
<td>Curriculum reform requires competency in cultural, political, societal, and ethical spheres, all of which are the responsibility of the teacher</td>
</tr>
<tr>
<td>Association of state policy with instructional alignment</td>
<td>Polikoff</td>
<td>2012</td>
<td>Policy and implementation varied widely, with no causal relationship determined between policy and instructional alignment</td>
</tr>
<tr>
<td>Decolonizing the curriculum</td>
<td>Subedi</td>
<td>2013</td>
<td>Decolonizing political lenses must be utilized to build a global curriculum</td>
</tr>
<tr>
<td>Role of district office leaders in implementation of CCSS</td>
<td>Durand et al.</td>
<td>2016</td>
<td>Leaders permitted CCSS adaptations and employed bridging, brokering, and buffering strategies to craft coherence and facilitate organizational learning and improvement</td>
</tr>
</tbody>
</table>

**Finance**

The Association for the Study of Higher Education (2011) cited funding disparities across school districts as one of the critical factors impacting student access to curriculum. More specifically, it was reported that student learning and achievement were negatively impacted by a lack of instructional materials and technology due to insufficient funding. Fiscal research into
public school effectiveness dates back several decades. Bracey (1997) discounted previous studies and myths regarding poverty. Bracey’s work opposing prevailing educational policies put financial resources as the most important factor in determining student performance outcomes.

Seeking a direct link between school resources and student outcomes has been the focus of many years of research and practical study (Greene et al., 2007). Educational researchers and policymakers alike seek this correlation in the hopes of influencing educational policy and finance. Yet, Greene et al. (2007) acknowledged additional variables existing within school districts; these variables include aptitude, family background and support, socioeconomic variables, and peer groups as influencers of student achievement. To address these issues, Greene et al.’s study expanded fiscal resources to include more direct, quantifiable variables that could be attributed to resource availability. These variables included student socioeconomic status, number of feeder schools per receiving school, class size, student–teacher ratio, and the number of advanced degrees maintained by teachers and faculty. When using these additional variables, the ability to predict postsecondary outcomes improved by 14% in comparison to using per pupil expenditures alone. These statistically significant findings imply the need for innovative human resource practices (resource allocation) and improvements to professional development and personnel evaluation (cultivating and supporting existing talent).

However, others would contend that financial resources alone cannot account for student performance. Relative to curriculum design, Hanushek (2012) argued that money is not as important to educational practices as is the predominating views in culture and society. Similarly, Kostakis (2014) used a statistical analysis of public investments, human capital, and political stability across 96 countries between 1990 and 2010. The study acknowledged a plethora of factors seeming to influence a country’s economic growth, including demographic
factors (fertility as an example), political determinants, regional variations, and issues attributed to larger, macroeconomic policies (such as inflation and government consumption). Although the study could not isolate singular factors as most influential in determining long-term fiscal health, the positive influence of public and private investment, total average years of schooling, and teacher–pupil ratio factors proved statistically significant. Table 2.4 summarizes studies on the funding of curriculum design and implementation.

Table 2.4

*Studies in the Funding of Curriculum Design and Implementation*

<table>
<thead>
<tr>
<th>Study</th>
<th>Researcher/author(s)</th>
<th>Date</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Money matters</td>
<td>Bracey</td>
<td>1997</td>
<td>Poverty impacts school performance outcomes</td>
</tr>
<tr>
<td>The relationship between school resources and student outcomes</td>
<td>Greene et al.</td>
<td>2007</td>
<td>Fiscal factors beyond per pupil expenditures play a larger role in determining student outcomes</td>
</tr>
<tr>
<td>Influence on minorities in the STEM circuit</td>
<td>Association for the Study of Higher Education</td>
<td>2011</td>
<td>Funding disparities impact access to curricular and instructional materials</td>
</tr>
<tr>
<td>Weighted student funding</td>
<td>Hanushek</td>
<td>2012</td>
<td>Funding alone cannot increase student performance outcomes; culture must be examined</td>
</tr>
<tr>
<td>Public investment, human capital, and political stability: determining factors of economic success</td>
<td>Kostakis</td>
<td>2014</td>
<td>Public investment is one of many factors influencing a nation’s long-term economic growth</td>
</tr>
</tbody>
</table>

**Deeper Complexities and Why Curriculum Matters**

Nearly 3 decades ago, Smith and O’Day (1990) highlighted curricular shortcomings as a barrier to school success. Their research generalized school curriculum as having “little depth or coherence” (Smith & O’Day, 1990, p. 239). Baker (1993) suggested a more ambitious curriculum in 1993 and continues to advocate for “an end to the crisis in curriculum theory” as
an inherently societal problem (Baker, 2015, p. 763). The following synopsis will summarize the many variables that have been researched as hindrances to effective curriculum development.

Kliebard (as cited in Allen & Hunsaker, 2016) contended that curriculum research, when separated from classroom instruction, assumes that teaching and learning are empirically controlled and thus do not impact outcomes. Further still, assuming empirical control over instruction assumes that all scholars and students value the curriculum equally (Kumashiro, 2000). Kumashiro (2000) summarized studies suggesting that successful, targeted instruction acknowledges and affirms student differences of race, sex, and other demographic variables. This approach is in stark contrast to traditional approaches to curriculum, which assume a “neutral” audience’s disposition to the content material (Kumashiro, 2000, p. 29). If a teacher’s students do not share the same social contexts or values as the curriculum developer, traditional approaches to curriculum theory will not work (Allen & Hunsaker, 2016).

Thus, Allen and Hunsaker (2016) advocated for a curriculum that responds to the uniqueness of each student. However, Eisner (1990) notes continual fluctuations in curricular approaches. Examples cited include industry leaders wanting more vocational applications embedded within the curricula, whereas feminists advocate for more “attention paid to gender issues in schools” (Eisner, 1990, p. 524). Thus, curriculum conservatives retreat to a stale, reemphasis of the disciplines while others fight to create a “curriculum that defines all of us” (Apple, 1990, p. 530). Apple (1990) argued that curriculum specialists have become irrelevant and relegated to simply following social movements. More recent studies (Holloway & Brass, 2018) boldly claim the following:

- Curricula in schools in the United States are poor.
- A more rigorous curriculum would positively influence student achievement.
• A combination of support and capacity building from outside of schools and districts is needed to sustain strong curricula.

• Existing policies push curricula towards mediocrity or in contradictory dimensions.

Au (2011) further highlighted the advent of high-stakes testing as a major influencing factor contributing to the regression of curricular quality. Scripted curricula lead to increasingly standardized “teaching to the tests” reminiscent of early 1900s principles of scientific management (Au, 2011, p. 30). The rigorous standards and high-quality assessments built into the 2009 RttT Act are reminiscent of functionalist concerns for efficiency dating back to Frederick Taylor’s 1911 Principles of Scientific Management (Glatthorn et al., 2018). Recent changes in curriculum theory (coinciding with educational policy and finance) favor a philosophical maximization of educational outputs with societal inputs (Clune, 1994). This will be further detailed in the next section.

**School Finance and Curriculum Design**

As referenced previously, the histories of school finance and curricular research leave many unanswered questions. Consequentially, many school funding models and curricula are “managed by inertia,” with year-to-year allocations remaining relatively stable (Psacharopoulos, 2006, p. 136). Both issues remain critically important in education research. According to Verstegen (2002), “With the national emphasis on teaching all students to high standards, new models of state finance systems are needed that align school funding more closely to standards-based reform aimed at high outcomes for all children and youths” (p. 749).

Verstegen’s (2007) study of one northeastern state’s school finance model examined funding levels necessary for schools to meet standards, laws, and objectives that define “an
adequate education” (p. 304). Verstegen determined that curriculum frameworks (as adopted by the state Board of Education) did not inform the development of the state’s school finance system. The funding for an effective school curriculum connects this issue with decades of research into equity and adequacy within school funding, and ultimately, educational policy (Satz, 2008).

At the district level, studies have examined resource allocation within individual school districts. Houck (2010) detailed the impact of school finance inequities on resource allocation and subsequent implications ranging from resegregated demographics to the unequal allocation of resources. Although this often leads to additional resources being dedicated to students from poor and minority backgrounds, these schools are not without their own challenges.

**Equity and Adequacy**

Springer et al. (2009) highlighted equity and adequacy as “the two most prominent principles in school finance policy” (p. 421), and broadly defined school finance equity as equal treatment for equally treated children. School finance adequacy prescribes educational resources sufficiently available to enable students to reach levels of proficiency. Brighouse (2004) contended that both ideals assume education to be not only a public good, but also a vehicle for social justice. To one extreme, research into educational adequacy yields the conclusion that education policy and reform are inadequate without attention to curriculum and educational theory (Macedo, 2013). Springer et al.’s (2009) study into court-mandated finance reform concluded that, regardless of the educational reform model (equity or adequacy), there were no statistically significant differences in resource distribution patterns and it was unclear if either resulted in greater spending for students requiring additional resources.
Furthermore, assessing the effectiveness of school district curricula is made difficult by a wide variety of influential factors. In light of the standards-based reform movement, Polikoff (2012) detailed these factors as systemic challenges to curriculum development:

- **Specificity** is the extent to which standards are clear and promote the intent of a given state’s education policy.

- O’Day and Smith (2019) highlighted operationalized *consistency* as the alignment between state standards and what is assessed on standardized tests.

- **Stability** is the degree to which standards remain unchanged over an extended period of time.

- **Power** is described as the rewards and/or sanctions tied to educational standards. As an example, some schools may face sanctions or closure if student achievement targets are not met (Supovitz, 2009).

- **Authority** is based on a teacher’s belief in a given policy/standard. Polikoff (2012) linked authority to the intrinsic motivation of teachers in the classroom.

In his conclusion, Polikoff (2012) implies that standardized assessments are often inconsistent with states’ educational standards, which lack specificity and are subject to change (on average) every 3 to 5 years.

**Inconsistencies in Defining Curriculum**

In their study of Grades 3–8 science learning, Zucker et al. (2008) found that the use of prescribed, research-based activities resulted in statistically significant gains in comparison to control groups, described as using a business-as-usual approach. However, Whitehurst (2009) pointed out the difficulties in establishing a study-by-study definition of what is encompassed within control groups. These groups, as opposed to students with teachers deploying a defined
curriculum under examination (the treatment group), could be exposed to another published curriculum, no curriculum at all, or more often, a teacher- or district-created curriculum.

Second, Steiner et al. (2017) noted the general lack of longitudinal studies in curriculum research. Such studies often explore impacts after a year or less, with researchers noting that the first year of implementation does not always yield consistent baseline data. In particular, comparison classrooms are often implementing business-as-usual practices, with the advantages of teacher familiarity and consistency. However, Steiner et al. did conclude that “curriculum is deeply important, and therefore a school’s choice of curriculum can make a substantial impact on their students’ learning” (p. 18).

Although there is general agreement that curriculum includes the content, sequence, and materials of a subject’s learning environment, the literature provides very different uses of the term. Relying on components of Whitehurst (2009), this study defined curriculum as the primary set of materials teachers use to deliver content to students in a particular subject area. Specific elements of this definition shall consist of (a) the predetermined scope and sequence of content and skills, (b) lesson plans, and (c) instructional materials, such as lab/experiment equipment. This definition does not include the untaught curriculum, defined by English and Steffy (2001) as including other, often intangible elements of the schooling experience.

**Elementary Science Curriculum & Instruction**

The What Works Clearing House is managed by the U.S. Department of Education and maintains stringent standards in identifying curricula or curricular resources through which impacts on student learning can be studied. The organization has only identified five science programs for studies that meet its inclusion criteria compared to 30 math and over 60 literacy programs (Steiner et al., 2017). Similarly, the Best Evidence Encyclopedia, produced by Johns
Hopkins University, reviewed 17 studies in elementary science education as opposed to 87 qualifying studies in mathematics.

Davis and Smithey (2009) described the challenges facing elementary school teachers when tasked with designing and implementing science curricula. Many elementary school teachers teach multiple subject areas, such as social studies, and the more-frequently assessed subjects of mathematics and ELA. Elementary science standards also cover a broad range of topics in each of the most common science strands: life science, physical science, and earth science. Last, teacher education programs rarely require more than introductory science level coursework. This leaves beginning elementary school teachers with gaps in content knowledge and a lack of familiarity with science practices (Howitt, 2007). Teachers with poor backgrounds in science or an overall lack of experience in teaching elementary science using inquiry-based methods experience difficulties in developing lesson plans.

Walker and Warfa (2017) described the inquiry-based approach to science instruction as one that encompasses “practices that embody the ways of doing science and the epistemic practices of the scientific enterprise” (p. 2). These science practices involve the processes of:

- posing questions,
- generating and testing hypotheses,
- analyzing and interpreting data,
- engaging in arguments (and citing evidence), and
- collaborating, leading, and participating in group activities as transferable skills.

As the school year progresses, students can engage with science content using deeper levels of sophistication (Maulana et al., 2016). In addition to the inclusion of inquiry-based instruction, Maulana et al. (2016) described the importance of properly ordering and sequencing
science content within a given curriculum. These two factors are common considerations in the development of elementary school science kits.

**Science Kits**

Four of the 17 studies reviewed by the Best Evidence Encyclopedia were described as inquiry-based programs that included science kits. These science kits were described as “the closest approximation of curriculum as they present clear content that students are expected to learn” (Steiner et al., p. 30). Programs included Full-Option Science System kits and Science and Technology for Children kits. These types of curricula focus on providing teachers with student-friendly, well-developed materials that allow them to use inquiry and hands-on laboratory exercises while engaging in traditional content. The use of inquiry-based models, as paired with science kits, produced the smallest average effect size (+0.02) when compared to the other models studied by the Best Evidence Encyclopedia. Inquiry-based programs (without science kits) produced an average effect size of +0.30, whereas technology-based programs yielded an average effect size of +0.37.

Many school districts are implementing science kits in elementary schools (Rennie et al., 2010) with some devising in-house models (Blanchard et al., 2013). Rennie et al. (2010) reported the following as benefits to science kit usage: (a) increased teachers’ core science knowledge, (b) increased teacher confidence, and (c) increased use of inquiry-based instruction. Rennie et al. went on to state that kit usage provides limited success when not paired with appropriately matched professional development to educate teachers in kit implementation.

Blanchard et al. (2013) also acknowledged the many variables associated with evaluating science kit effectiveness; these variables include the frequency of kit usage, faithful implementation of kits as designed, supplemental instruction to science kits, and immeasurable
student and teacher variables. Blanchard et al. concluded that the presence of science kits, “with accompanying lesson plans and materials all in one location and by topic” (p. 42) has increased the prevalence of inquiry-based science instruction at the elementary level. In addition, Blanchard et al.’s interviews with elementary science teachers indicated that science kit implementation would be further assisted by an effective lesson-development process, as guided by curriculum planners.

**Conceptual and Theoretical Framework**

The conceptual and theoretical framework of this study was based on systems thinking analysis of one North Carolina school district as a complex system. When analyzing the inputs and outputs of an organization, systems concepts have long been described as a way to detail observable patterns within an organization (Katz & Kahn, 1966). The mapping of science kits and their subsequent implementation in the CHCCSD were analyzed as a complex system, defined by Clancy et al. (2008) as a “highly connected network of entities” (p. 249). Complex systems can include physical objects, people, or groups of people from which higher orders of behavior emerge. Systems can become complex when there are many combinations of events at a point in time, such as changes in funding, changes in standards/curriculum, or changes in group dynamics. A student’s response to science kits can be unpredictable given the vast array of variables at work. The task of teaching science kits can become complex within the social systems of schools and school districts.

Complexities of social organizations have been historically grounded in organizational theory (Anderson, 1999). Systems thinking is grounded in theories of nonlinear dynamics and feedback control (Clancy et al., 2008). In advocating for a systems thinking approach to education, Soderquist and Overakker (2010) began by detailing the inadequacies of traditional,
business-as-usual or “ways of thinking” approaches to policymaking and implementation (p. 194). These “common ways of thinking” and their disadvantages are summarized in Table 2.5.

**Table 2.5**

*Common Ways of Thinking: Disadvantages*

<table>
<thead>
<tr>
<th>Mental model</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Focus on events (instead of patterns)          | Limit ability to predict patterns  
Foster reactive behavior                        |
| Apply spatial boundaries that are too narrow   | Promote commodity cycles of funding  
Reduce ability to predict cause and effect     |
| Underestimate time delays                      | Inhibit long-range planning  
Highlight human inability to apply an effective, longitudinal lens |
| Assume causality                               | Ignore the importance of feedback  
Assume one-way causality                       |
| Avoid simulating unintended consequences      | Overlook feedback loops  
Reduce potential policy impacts                |
| Exclude intangibles                            | Focus solely on quantifiable outcomes  
Overlook variables such as motivation, trust, knowledge, or skills |

Soderquist and Overakker (2010) proposed systems thinking as a framework for collaboratively building and communicating more effective mental models that address the shortcomings listed in Table 2.5. Systems thinking involves “processes, sets of skills, and technologies” that allow researchers to better understand the world and propose ways to act more effectively in practice (Soderquist & Overakker, 2010, p. 197). Processes apply a methods-based approach to arrive at credible conclusions with effective recommendations.

Table 2.6 outlines a set of skills that build capacity for systems thinking. These skills, as proposed by Kordova et al. (2018), address the inadequate mental models referenced in Table 2.5.
Table 2.6

*Skills for Systems Thinking (Kordova et al., 2018)*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Skill</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framing issues</td>
<td>Dynamic thinking</td>
<td>Look for trends and patterns (shift from focus on events)</td>
</tr>
<tr>
<td></td>
<td>10,000 meter thinking</td>
<td>Look at the Big Picture</td>
</tr>
<tr>
<td></td>
<td>Systems as cause thinking</td>
<td>Examine only the elements whose interactions self-generate the examined phenomenon</td>
</tr>
<tr>
<td>Building understanding</td>
<td>Operational thinking</td>
<td>Look for explicit causes of behavior</td>
</tr>
<tr>
<td></td>
<td>Feedback loop thinking</td>
<td>Move from linear thinking to circular causality</td>
</tr>
<tr>
<td></td>
<td>Scientific thinking</td>
<td>Apply scientific method to analysis</td>
</tr>
<tr>
<td></td>
<td>Generic thinking</td>
<td>Apply generic structures (e.g., ecosystems, economies) to the world</td>
</tr>
<tr>
<td>Communicating</td>
<td>Empathic thinking</td>
<td>Expand boundaries to understand other perspectives and/or models</td>
</tr>
</tbody>
</table>

In addition to the systems skills used within systems thinking, models are often employed to operationally map a series of interconnected elements (Soderquist & Overakker, 2010). The causal loop diagram is one model used to illustrate reinforcing or balancing loops within a system (Tsaple & Panayotis, 2019). Causal relationships are observed and recorded between elements and variables within a system. These relationships can be positive feedback loops, whereby results tend to reinforce what is happening, or negative feedback loops in which results oppose or react to change processes. Causal loops do not predict what is going to happen to a system, but instead represent the structures within a system. The behavior of these structures can thus be examined over time. As one final note, increases (or decreases) of a particular variable do not necessarily yield a corresponding result, as systems often maintain more than one input.

This study utilized systems thinking to analyze the relationship between cost inputs, science kit implementation, and intradistrict spending. Limitations of this study, as discussed in the following chapter, include a singular focus on one school district.
Conclusion/Summary

Effective classroom teaching relies upon the consistent delivery of a distinct course of study. More recently, centralized curriculum models have challenged states, districts, and schools to adapt to frequent changes in standards. Research chronicles the historical influences of culture, politics, and finance on standards and curriculum development. It is evident that more research is needed in several areas, including the effectiveness of curricula and how to examine the relationship between funding and curriculum design and implementation. Variability in school funding models presents difficulties in assessing the effectiveness of school district curricula. These challenges include a recurring lack of specificity, consistency, and stability. There is little research into the mechanics used by states or districts in assessing curricula development. When curriculum is viewed as the roadmap between standards and classroom instruction, standardized tests often yield insufficient data or are inconsistently aligned with content standards. This study relies on Whitehurst’s (2009) inclusion of materials in defining curriculum as it examined the relationship between district-provided curricular materials, funding for these materials and their implementation, and the allocation of these resources within a district.
CHAPTER 3: METHODOLOGY

This chapter details the process used to analyze the distribution of funds in designing and implementing curriculum. The first section outlines the purpose of the study and accompanying research questions. The second section provides an overview of the data used for the research. Next, information used to analyze the data in this descriptive case study is presented. The next section is an overview of the methods used to conduct the study, analyze the available data, and describe the perceived outputs of the Instructional Services Division. The penultimate section provides details about my background and its potential impact on conclusions and policy suggestions. The chapter concludes with a discussion of the study’s limitations and significance.

Purpose of the Study

This study was designed to analyze the relationship between educational standards, school district expenditures, and curriculum design and implementation. The Instructional Services Division of the CHCCSD oversees all aspects of teaching and learning in Grades PreK–12. This department accounted for approximately $4,000,000 in expenditures in the 2015–2016 fiscal year. The purpose of this study was to explore the financial implications of curriculum articulation in this North Carolina public school district. I sought to report revenue sources and funds spent on curriculum articulation, analyze historical trends within this funding model, and determine whether suggestions can be made to practitioners when planning for major standards initiatives and/or revisions. Last, the study provides information for future curriculum development and change. The research questions from Chapter 1 are restated below.
Research Questions

1. What revenue sources fund the design and implementation of elementary science curriculum?

2. How are funds expended in the design and implementation of elementary science curriculum?
   a. To what extent do school districts invest in these efforts vis-à-vis science kits?
   b. How are these expenditures allocated across schools within a district?

3. What guiding principles or district goals influence the design of curriculum?

4. What longitudinal data support the implementation of curriculum?

To answer these questions, I used primary documents from the CHCCSD over a 3-year period (2015–2017). This case study closely examined the role of a central office administrator, along with the topics and programs associated with K–12 science within the district. After a description of case study methods, subsequent sections will frame data and data organization around the above research questions.

For this study, I used a descriptive case study method for two primary reasons. First, a goal of the case study was to develop an understanding of the boundaries associated with the system. One primary purpose of case study research is to understand the established scope of a study; that is, how groups, organizations, etc. interact within a theoretical framework. Additionally, descriptive case studies help to answer research questions based on theory, which aligns with the second goal of the study. Descriptions of curriculum development developed throughout the research process assisted in identifying theoretical frameworks under which curriculum development operates.
The study yielded a deeper understanding of what curriculum development looks like at the district level. Practitioners may utilize this insight to adjust curriculum articulation to meet the needs of their school districts. Administrators within the CHCCSD may share the results with the community or the Board of Education as an example of the curriculum development at work within the district. Teachers and building administrators may gain a better understanding of district-level happenings and apply this knowledge to their practice.

**Data Organization**

This section provides an overview of data sources, their organization, and their relation to each research question. Each research question is listed along with data sources and a description of how the data were obtained. The following section describes methods used for analysis of the obtained data.

*Research Question 1: What Revenue Sources Fund the Design and Implementation of Elementary Science Curriculum?*

I retrieved historical demographic data from the North Carolina Department of Public Instruction. A searchable database details data for individual school districts. In addition, data were collected from the Business and Financial Services Division of the CHCCSD. These data included annual budget expenditures, comprehensive annual financial reports, and state expenditure data. Lastly, meeting notes, agendas, and intradistrict correspondence records detailed curriculum work within the Instructional Services Division of the CHCCSD.

**Fiscal Data.** As a first step in the data collection process, I organized financial data collected from the Business and Financial Services Division of the CHCCSD. The goal was to collect, aggregate, and report short-term financial data at the district level. Table 3.1 illustrates
three primary revenue sources for the CHCCSD for the sample year 2013–2014. A detailed description of these revenue sources is also included.

Table 3.1

Revenue Sources for CHCCSD (2013–2014)

<table>
<thead>
<tr>
<th>Revenue source</th>
<th>2013–2014 amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local revenue</td>
<td>$71,205,206</td>
</tr>
<tr>
<td>State revenue</td>
<td>$61,802,887</td>
</tr>
<tr>
<td>Federal revenue</td>
<td>$4,426,844</td>
</tr>
<tr>
<td>Total revenue 2013-2014</td>
<td>$137,434,757</td>
</tr>
</tbody>
</table>

Local revenue includes all revenue for local sources, including revenue from local and nonproperty taxes, investments, student activities, textbook sales, tuition fees, and food service. State revenue includes direct funds from the state of North Carolina and revenue in lieu of taxation. The funds in the latter category are paid to compensate individual school districts for nontaxable state institutions or facilities within the district’s geographical boundaries. Federal revenue includes federal appropriations received from the North Carolina Department of Instruction. These funds are typically held in the State Fund and released as needed by the State Treasurer. These data were taken directly from the comprehensive annual report released each year by the CHCCSD.

Research Question 2: How are Funds Expended in the Design and Implementation of Elementary Science Curriculum?

Budget Allocations. As a second step in organizing the collected fiscal data, annual budget allocations were reviewed to isolate those funds allocated to Instructional Programs. Allocations reviewed included those for special programs, alternative programs and services, cocurricular activities, school leadership, school-based support services, and other expenses
associated with the interaction between students and teachers (CHCCSs, 2016a). As defined by the district, teaching may be provided for students in a classroom or other location such as a home or hospital and in other situations such as those involved in extracurricular activities. Teaching also occurs through other approved media. Instructional services include the costs of salaries and benefits for teachers, instructional assistants, instructional leadership, and support staff. Contracted instructional services include instructional supplies, materials and equipment, professional learning/development, and other costs related to the instruction of students. The CHCCSD also includes under instructional services the cost of activities involved with the evaluation, selection, and implementation of textbook materials and other instructional tools and strategies. In addition, curriculum development and delivering staff development are included here.

**Regular Curricular Services.** Within the Instructional Services allocation, budget codes and expenditures within the curricular services account were analyzed, including the cost of activities that provide learning experiences to students in Grades K–12. These codes and expenditures also include the cost of those individuals responsible for providing school curriculum development and coordination. This line item does not include programs designed to improve or overcome physical, mental, and/or social/emotional concerns that impeded learning (CHCCSs, 2015a). The data set provided by the Business and Financial Services Division can be queried based on public resources codes that denote specific expenditures. Access to source documents, such as invoices paid and amounts, are to be specified within the data set.

**Research Questions 2a and 2b**

This section describes the data organization related to Research Questions 2a and 2b. These research questions are restated below:
2a: To what extent do school districts invest in the design and implementation of elementary science curriculum vis-à-vis science kits?

2b: How are these expenditures allocated across schools within the district?

In 2015, the CHCCSD maintained Science Kits for 11 K–5 elementary school buildings. In the years leading up to the time of research, these kits were rotated between the elementary schools. Math/Science Specialists serviced these kits on site to coordinate delivery to classroom teachers and assist with implementation. Each grade level received between three and four kits per school year, with each kit remaining on site for approximately one quarter of the school year. Because these kits were shared between buildings, during each quarter, each elementary building could be teaching one of four different kits/topics.

Data were collected from each of 12 Math/Science Specialist meetings hosted by the district’s Science Coordinator. The primary focus of these meetings was curricular alignment among the 11 elementary schools. Collected data included meeting agendas, correspondence prior to and after the meetings, attendance, and subsequent implementation of the redesigned elementary science curriculum. I limited data collection to one grade-level band (K–5) within one school district to make the amount of data collection manageable.

Data were collected through archived financial records, agendas, documentation, and correspondence between 2015–2017. Data collected were both quantitative and qualitative. Table 3.2 offers a brief description of how and what data were collected and analyzed in this study.
Table 3.2

*Research Design Plan*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Data source(s)</th>
<th>Analytic method(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What revenue sources fund the design and implementation of elementary science curriculum?</td>
<td>Annual financial reports</td>
<td>Document analysis, Descriptive trends in revenue over time</td>
</tr>
<tr>
<td>How are funds expended in the design and implementation of elementary science curriculum?</td>
<td>Annual financial reports</td>
<td>Document analysis, Descriptive trends in expenditures over time</td>
</tr>
<tr>
<td>To what extent do school districts invest in these efforts vis-à-vis science kits and how are these expenditures allocated across schools within a district?</td>
<td>Annual financial reports, Math/science specialists, Administrators</td>
<td>Document analysis, Memo writing, Descriptive trends in science kit implementation over time</td>
</tr>
<tr>
<td>What guiding principles or district goals influence the design of curriculum?</td>
<td>Math/science specialists, Administrators</td>
<td>Document analysis, Memo writing, Observed patterns in principles and district goals</td>
</tr>
<tr>
<td>What longitudinal data support the implementation of curriculum?</td>
<td>Math/science specialists, Administrators</td>
<td>Document analysis, Memo writing, Descriptive trends in the assessment of curriculum implementation</td>
</tr>
</tbody>
</table>

*Research Question 3: What Guiding Principles or District Goals Influence the Design of Curriculum?*

**Document Analysis.** The goal of analyzing documents is to identify underlying themes within the materials, analyze these themes, and provide interpretation that augments a theoretical argument (Briggs et al., 2012). Each category of document detailed in the previous section was assessed according to four criteria. These criteria, as adapted from Briggs et al. (2012), are described in Table 3.3.
Table 3.3

Four Criteria Used to Assess Documents

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authenticity</td>
<td>Soundness and authorship of documents:</td>
</tr>
<tr>
<td></td>
<td>Is the document an original? A copy?</td>
</tr>
<tr>
<td></td>
<td>Is the document complete?</td>
</tr>
<tr>
<td></td>
<td>Who authored the document?</td>
</tr>
<tr>
<td>Credibility</td>
<td>Accuracy of the documents:</td>
</tr>
<tr>
<td></td>
<td>Is there additional information about the author?</td>
</tr>
<tr>
<td></td>
<td>Are there secondary sources of information related to the documents?</td>
</tr>
<tr>
<td>Representativeness</td>
<td>Survival and availability of the documents:</td>
</tr>
<tr>
<td></td>
<td>Are the selected documents representative of the environment?</td>
</tr>
<tr>
<td></td>
<td>Is there bias present in the document?</td>
</tr>
<tr>
<td>Meaning</td>
<td>Interpretation of the document:</td>
</tr>
<tr>
<td></td>
<td>What is the literal interpretation of the document and its language?</td>
</tr>
<tr>
<td></td>
<td>What quantitative data can be analyzed from word count?</td>
</tr>
<tr>
<td></td>
<td>What qualitative significance is there in words, terms, or image?</td>
</tr>
</tbody>
</table>

To situate data within the case study, I sought to understand the context in which documents were generated. The range of relevant documents was categorized in a manner that would guide additional collection of data, revision of categories, and the generating of responses to the previously stated research questions. Appendix A displays the template used for documentary analysis, as adapted from Altheide (2004).

**Memo-Writing.** Through the lens of systems theory, I aimed to incorporate qualitative and anecdotal reports of the human experience through the craft of a new narrative, which accompanies fiscal data, archival records, and other documents within the case study database. The goal of memo-writing is to extract meaning from the data in a way that expresses data in conceptual terms (Birks et al., 2008). The following steps (adapted from Yin, 2011) describe the format/structure and substance of the memos composed:
1. Each memo was assigned a title to reflect the nature and content of the data to be analyzed.

2. Memos were dated and cross-referenced to other memos and data of relevance from within the case study database.

Through this process, the main purpose of memo-writing as an analytic tool was to document any connections between specific pieces of evidence and the many issues at play within the case study.

**Research Question 4. What Longitudinal Data Support the Implementation of Curriculum?**

**Documentation.** When used in case study research, documentation is used to “corroborate and augment evidence from other sources” (Yin, 2017, p. 115). Advantages of the use of documentation include the ability to repeatedly review documents in a nonobtrusive manner. The use of CHCCSD agendas, meeting minutes, and financial data was specific in the inclusion of exact names, references, and details of events such as meetings. The collected documentation allowed for flexibility in covering adjustable spans of time. These strengths of documentation allowed for a more robust understanding of the physical and social environment being studied (Glesne, 2011).

The collection and organization of documents must be based on the methodology of the study (Glesne, 2011). Although the implementation and delivery of science kits can be assumed through financial records, district correspondence and published schedules detailed what this implementation represented in classrooms. These documents and resources provided insight into the role of Math/Science Specialists and administrators in the elementary science program. I used the following primary source documents in this study:

- email correspondence maintained by the CHCCSD,
• comprehensive annual reports as presented by the CHCCSD Office of Budget and Finance,
• budget proposal documents,
• Board policy as adopted by the CHCCSD’s Board of Education,
• CHCCSD’s Long Range Plan, and
• meeting agendas and minutes of the regular meetings of Math/Science Specialists.

These documents were maintained and archived by the Science Coordinator of the CHCCDS, are available online, or were accessible through public records requests.

Data Analysis

I used a combination of qualitative and quantitative data to approximate the costs associated with implementing shifts in curriculum implementation for one school district in the state of North Carolina. This section details the data analysis methods used to develop this descriptive case study that sought functional findings.

Trends in Resources over Time

Yin (2011) described time-series analysis as one of many analytic strategies used within case studies. This study used a time-series design to analyze spending on science kit implementation as a single measure to be tracked over time. Though implementation was represented by a large amount of data across time (from planning to implementation), the use of time was one measure through which the data were analyzed. The time period analyzed was 2015–2017, a truncated segment of the CHCCSD’s broader use of science kits.

Narrative Compilation

In addition to the previously mentioned data sources, I compiled evidence under the similar theme of science kit implementation. This compilation of my personal narratives sorted
evidence in a manner that determined support for themes and ideas (Yin, 2011). Primeau (2003) recognized the influence of the researcher’s own subjectivity in the collection and interpretation of data. However, Birks et al. (2008) argued that the relationship between researcher and data in qualitative research is critical to the generation of knowledge that acknowledges the “breadth and depth of human experience” (p. 69).

Glesne (2011) acknowledged the critique that qualitative case studies are often viewed as subjective. The present research and analysis process sought credible findings with an additional analysis of my interpretation of the data. I used data triangulation with multiple sources of evidence to support the case study’s findings. Finally, I examined convergent evidence, as represented in Figure 3.1, to strengthen the construct validity of the study.

**Figure 3.1**

*Convergence of Multiple Sources of Evidence*
The operational measures defined in Figure 3.1 identified the concepts being studied. This was my attempt to develop a sufficiently operational set of measures to eliminate subjectivity associated with a researcher’s preconceived notions (Flyvberg, 2016). Flyvberg (2016) further described one oversimplification of case study research: “One cannot generalize on the basis of an individual case” (p. 221). As Flyvberg would describe this misunderstanding, this argument concludes that a case study cannot contribute to scientific development.

Notwithstanding, this study pursued suggestions for practitioners to use when planning for major standards initiatives and/or revisions. The information gained through this research could provide school administrators and policymakers with information regarding standards delivery.

**Case Study Rationale and Researcher’s Role**

This dissertation represents a single case study that sought to provide a detailed explanation of the financial data and outcomes of one North Carolina school district’s spending on curriculum development and implementation. Specifically, the study analyzed the CHCCSD’s use of elementary science kits. Given the relative lack of data regarding curriculum development and constantly changing, state-imposed standards, gaining insight into school district approaches to curriculum writing could prove relevant.

In one Canadian study, Godden (2013) highlighted the need for effective curricula to inform industry-specific career studies for students by citing the threat of rising unemployment within a fragile global economy. Godden argued for the closer alignment of job market skills and school curriculum. In reaction to the threat of youth unemployment, the push for curricular alignment (and increased spending therein) has been effected by policy changes enacted by the Organization for Economic Cooperation and Development. A case study of one district’s
expenditures on curriculum development is unique and may inform future policy. Though this study has many limitations, it provides useful information for practitioners.

During my research, I was a curriculum coordinator whose primary responsibility was the facilitation of curriculum development in the CHCCSD. This presented the possibility of bias, but also provided me with detailed experience in curriculum writing. Here again, curriculum is defined to include the sets of materials teachers use to deliver content to students in a particular subject area (science kits in elementary science curriculum). My work involved hours of individual and small-group meetings with teachers and administrators; thus, I was aware of the many factors involved in developing and implementing curriculum. Examples of these factors include budget considerations, district programs, school staffing, and district and school goals. I was able to contextualize implications of the many factors that influence curriculum development, the use of various data points, and any opportunities for policy changes and future research.
CHAPTER 4: FINDINGS

This chapter presents the results of the study. Charts, tables, and narratives that describe sample documents are included. This chapter is organized by the study’s research questions as it presents relevant results for each question defined in Chapter 1 using the research methods described in Chapter 3.

Because this dissertation focuses on science kit use as an example of curriculum design and implementation, an overview of district spending is provided before describing specific funds associated with the district’s use of science kits. Percentages of corresponding funding sources are calculated and reported. All reported dollar amounts are adjusted for inflation to a common reference year (see Appendix B for conversion factors).

Each section uses time series analysis to review events related to science kit implementation as tracked over time in answering the research question and subquestions. Utilizing a systems theory approach, I review relevant data pertaining to the design of a new elementary science kit rotation in one school district. Uncovered sociocultural systems are described along with their interactions. These systems are then analyzed for conflict or cohesion in the development of a new model for science kit implementation.

The final section summarizes the descriptive timeline to detail the work conducted by the Science Coordinator for the district. Corresponding narratives summarize relevant events and documents pertaining to key themes documented within the research.
Document Analysis

A collection of documents and resources were reviewed to gain insight into the role of Math/Science Specialists and administrators in the elementary science curriculum. Primary source documents reviewed included:

- email correspondence maintained by the CHCCSD,
- comprehensive annual reports as presented by the CHCCSD Office of Budget and Finance,
- budget proposal documents,
- Board policy as adopted by the CHCCSD Board of Education,
- CHCCSD’s Long Range Plan, and
- meeting agendas and minutes of the regular meetings of Math/Science Specialists.

I utilized time-series analysis to analyze spending on science kit implementation as a single measure to be tracked over time while addressing the research questions. As an overview of the CHCCSD science curriculum work, the following sections detail sequential data relevant to the development of elementary science curriculum between 2014–2017 through the lens of each research question. The truncated timeline will then be examined to highlight relevant themes within the district’s renewed focus on elementary curricula.

Throughout the 2014–2015 school year, the Science Coordinator for the CHCCSD met regularly with other administrators within the Instructional Services Division, building-level administrators, and school-based planning teams. Much of this work focused on the district’s goal to promote instructional excellence. This goal was accompanied by the following objectives: (a) the development of a timeline for the review and writing of curriculum across
Grades PreK–12, and (b) the inclusion of a process for curriculum development that includes participants, expectations, and oversight with regard to curriculum implementation.

Progress towards this goal was achieved throughout the 2014–2015 school year with the establishment of Instructional Planning Teams at both the middle school (Grades 6–8) and high school (Grades 9–12) levels. These teams met regularly to review school district goals and their impact on curriculum design, the integration of cross-curricular units in STEM, and a unit-design template to be used in planning common units to be shared across the 6–8 learning community.

The Science Coordinator continued his work within the Instructional Services Division during the 2015–2016 school year. Curriculum writing work continued within the Instructional Planning Team (Grades 6–8) utilizing the previously established unit-design template. In addition, the Science Coordinator began meeting with staff members at the elementary (Grades K–5) level to review and revise the implementation of elementary science kits.

Throughout the timeline and accompanying narrative, I will reference Math/Science Specialists. During the science coordinator’s work within the CHCCSD, the district employed these staff members (one at each elementary school). According to the CHCCSD recruiting website, the job goal for this position is to develop and implement a “hands-on and minds-on science program” coordinated with state standards and specific to each site (CHCCSs, 2020). Developing units and kits to facilitate science and math instruction is further referenced under performance responsibilities. The Math/Science Specialists met regularly with the Science Coordinator and served as school-based representatives in the development and refinement of the elementary science curriculum.

The following synopsis was collected from notes, documents, and communications related to elementary (Grades K–5) science curriculum. The described timelines in subsequent
sections focus more specifically on the events, documents, and communications pertaining to elementary (Grades K–5) science curriculum. In 2014, the Science Coordinator was asked to examine the district’s use of science kits, their alignment to standards, and fidelity of implementation within the district’s 11 elementary schools. As such, an emphasis is placed on science kits and their implementation in the timeline.

**Research Question 1: What Revenue Sources Fund the Design and Implementation of Elementary Science Curriculum?**

To begin compiling revenue sources, I first examined the total revenue for the CHCCSD. This included three primary sources: local, state, and federal revenue. The goal was to collect, aggregate, and report short-term financial data at the district level. This section includes tables detailing these revenue sources as percentages of total annual revenue. A preview of total expenditures is also included. In an attempt to connect funding sources to the elementary science curriculum, budget codes are also described and analyzed in Table 4.3. This allowed me to identify elementary science kits as a locally funded initiative.

I analyzed data from the North Carolina Department of Public Instruction to obtain demographic data for the CHCCSD. Data were also collected from the district’s Business and Financial Services Division. This included annual budget expenditures, comprehensive annual financial reports, and state expenditure data. Utilizing budget records for the Instructional Services Division, account codes were reviewed to identify funding sources for elementary science kits.

The information in Figures 4.1 and 4.2 details the CHCCSD’s financial perspective for the 2014–2015 fiscal year. This information was gathered from the approved budget released annually by the Board of Education and includes all government and business-type activity.
Figure 4.1

CHCCSD’s Revenue Sources 2014–2015

State of North Carolina $61,023,224
Orange County $52,228,906
Federal $6,183,854
School Food Service $3,747,285
Child Care $1,911,103
Other $27,396,805
Total $152,491,179

Note. Adjusted for inflation.
### Figure 4.2

**CHCCSD’s Expenses 2014–2015**

<table>
<thead>
<tr>
<th>Service</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Services</td>
<td>$107,252,550</td>
</tr>
<tr>
<td>Support Services</td>
<td>$26,608,758</td>
</tr>
<tr>
<td>Ancillary Services</td>
<td>$60,466</td>
</tr>
<tr>
<td>Payments to other governments</td>
<td>$806,843</td>
</tr>
<tr>
<td>Depreciation</td>
<td>$6,886,628</td>
</tr>
<tr>
<td>School Food Service</td>
<td>$4,104,998</td>
</tr>
<tr>
<td>Child Care</td>
<td>$1,580,265</td>
</tr>
<tr>
<td>Other</td>
<td>$24,306</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$147,324,813</strong></td>
</tr>
</tbody>
</table>

*Note.* Adjusted for inflation.

As approved in each budget resolution, all appropriated funds were to be paid “first from revenues restricted to use, and second from general unrestricted revenues” (CHCCSs, 2019, p. 11). This protocol was reiterated to the Science Coordinator during the August 19, 2014 meeting with the Assistant Superintendent for Instructional Services. The superintendent and other designees were also authorized to transfer appropriations within a fund under specific conditions:
A. Amounts may be moved between subfunctions and objects of expenditures within a function. Amounts may also be transferred in state, federal, and grant programs with prior approval from the funding agency.

B. Amounts may be transferred between functions of the same fund when amounts change 10% or more of the line item. This must be accompanied by a report at a meeting of the Board of Education.

Additionally, amounts may not have been transferred between funds or from appropriations within funds unless required to recategorize and account for such funds. Additionally, such restrictions could have been suspended for year-end closeout only provided that transfers were accompanied with an explanation of extraordinary/unusual circumstances in final audit statements.

A different view of these data is provided through the analysis of district-level account codes. Account codes indicated that these funds were located within the budget of the Assistant Superintendent for Instructional Services. The entirety of this budget was comprised of state and local funds, averaging approximately $1.5 million annually over the same time period. These funds were noted with a purpose code to indicate usage, and these purposes included activities or expenditures that were “performed to accomplish the objectives” of the school district (CHCCSs, 2021, p. 67). Table 4.1 further details the account code structure used by schools within the state of North Carolina. The example used details the accounting for science kit expenditures.
Table 4.1

**Account Code Structure Example: Science Kits – Contracted Services**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>As used for science kits example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund code</td>
<td>The accounting structure utilizes six funds and a self-balancing group of accounts for use by a school district.</td>
<td>2- Local Current Expense Fund – Appropriated for the current operating expenses of a school system other than appropriations included in the State Public School Fund and Federal Grant Fund. Revenue source examples include supplemental taxes and county appropriations</td>
</tr>
</tbody>
</table>
| Purpose code | Purpose dictates the activities/actions that are performed to accomplish school district goals. Purpose codes indicate the reason for which a specific account exists. Additional dimensions are accounted for in each subsequent digit of the coding structure. | 6000- System-Wide Support Services  
6900- Policy, Leadership, and Public Relations Services- encompass costs of activities related to the general administration of a school district |
| Program report code | A program report code indicates a plan of activities and/or funding designed to accomplish an objective, allowing a district to classify expenditures by program to determine cost. | 061- State and Federal Funds defined by the North Carolina Department of Public Instruction |
| Object     | Object delineates the service or commodity obtained through a specific expenditure. | 311- Purchased services (300) are one of seven major categories (100-700) |
| Location   | Location codes indicate specific expenditures. For example, each school within a district is assigned a location code, and funds dedicated to each specific building are thus noted with the appropriate location code. | 000- Uncategorized location code indicates expenditures utilized across an entire school district |
| Use codes  | Use codes can be used internally to further distinguish departments, projects and/or uses. | 290- Elementary science kits |

Budget documents generally described 6000 level purpose codes (system-level services) to include “the costs of activities providing systemwide support for school-based programs” (CHCCSs, 2015a, p. D-2). Furthermore, this purpose code applied regardless of where these supporting services were based or housed. System-wide support services provide technical,
personal, and logistical support to facilitate, sustain, and/or enhance instruction. Contracted support services, supplies, materials, and equipment were also included here along with any other costs related to the system-wide support for school-based programs of the school system.

Thus, the district’s adjusted for inflation $193,530 expenditure for 2014–2015 Elementary Science Kits can be defined as a locally funded, system-wide support service related to the general admission of a school district. This represents less than 0.5% of the district’s $52,000,000 local expenditures. Similarly, funding for curriculum planning work originated from the same sources. Funds were defined per the North Carolina Department of Public Instruction as purchased services.

**Systems Theory Analysis.** Findings in this section begin to highlight connections between funding sources and curriculum. Golebiewski (2011) provided an overview of the literature and research measuring education cost differentials, very few of which targeted curriculum implementation. Although a variety of fiscal factors play a role in determining student outcomes (Greene et al., 2017), a report by the Association for the Study of Higher Education (2011) pointed to funding disparities that impact access to curricular and instructional materials, particularly in the field of science. Local revenue sources such as supplemental taxes highlight inter-district funding disparities that impact access to curricular and instructional materials.

Another related concept applies state and federal funds to supplement materials such as science kits. Munley and Harris (2010) analyzed state-based aid programs for equalizing spending across local school districts, but no such program was in place in North Carolina in 2015. O’Day and Smith (2019) highlighted such funding inequalities as a factor in determining the quality of education within schools and districts. State-supported, weighted student funding
models continue to be researched as a financial means to enhance intra-district equity (Grosskopf et al., 2017).

However, science kits, elementary curriculum, and the systems impacting the implementation of both cannot be analyzed strictly within narrow spatial boundaries such as funding. Doing so reduces funding models to commodity cycles and limits any ability to predict cause and effect. To operationalize connected systems and their channels of behavior, I explored both additional, quantifiable outcomes and analyzed intangibles that can also impact the channels of communication and systems that drive implementation.

As the chapter continues to answer the study’s research questions, expenditures and the relationship between funding and curriculum design will be further unpacked (see Figure 4.3). The materials associated with classroom instruction, as represented by science kits, are also analyzed. Furthermore, potential conflicts are explored in the at times inequal distribution of funds within the science kit model.
The quantitative data described in this section establish the basis for answering subsequent research questions. Fiscal data were reviewed along with qualitative data to approximate the costs associated with implementing shifts in curriculum implementation. This shift occurred between the years of 2015–2017. My analysis of documents, reports, and correspondence highlights the CHCCSD’s efforts to support curriculum across the district.

Exploring Research Question 2b uncovered discrepancies in the funding level of individual schools within the same district. Qualitative methods were used to categorize cultural and historical influences within the district that contributed to these disparities. Other themes that impact the development of curriculum are explored in subsequent research questions and further discussed in Chapter 5.
Research Question 2: How are Funds Expended in the Design and Implementation of Elementary Science Curriculum?

I reviewed annual budget allocations as I continued organizing fiscal data. Within budgets allocated for regular curricular services, science-curriculum-related expenditures were analyzed over a multiyear span. This section details the use of these funds in both the design and implementation of elementary science curriculum.

Memo-writing was utilized to compile the following narrative. In analyzing data sources, I sought to detail common themes within meeting agendas and minutes, correspondence, and department documents. After research notes are presented chronologically, analysis is provided to document connections between evidence and any issues revealed to be impactful to the research question. Tables are included to display these expenditures over a 5-year period. These expenditures are then compared to the revenue sources described in the previous section.

Key Dates and Themes. On August 19, 2014, the newly hired Science Coordinator for the CHCCSD met with the Assistant Superintendent for Instructional Services to discuss the Coordinator’s new role within the district. Three key themes from this meeting included budget and planning, the current state of unit planning within a larger district science curriculum, and the current implementation of science kits at the elementary level. The Science Coordinator was asked to utilize a critical, information-gathering lens in examining the usefulness of these kits.

When adjusted for inflation, the CHCCSD allocated approximately $4,000,000 for the Instructional Services Division in the 2015–2016 fiscal year. This division oversees all aspects of teaching and learning in Grades PreK–12. Employed within this department were nine subject coordinators tasked with facilitating the design and implementation of district-wide curriculum.
The district’s Science Coordinator was tasked with redesigning science curricula across the district.

**Longitudinal Funding.** Budget documents for each of the 3 years prior to the 2015–2016 academic year were analyzed to calculate the percentage of the district’s total expenditures allotted for Instructional Services and contracted services for science kits. Tables 4.2 and 4.3 display the longitudinal data compiled for these 3 years.

During the 2014–2015 academic year, the Science Coordinator began reviewing the historical costs associated with science kit implementation within the district. As referenced in Table 4.2, these expenditures ranged from $200,830 to $215,836 in the time period between 2012 and 2017 (adjusted for inflation). As detailed in the accounting report for these costs, funding for science kits came directly from the Local Current Expense Fund. According to the district’s Budget Development Document (2021), these local current expenses included, but were not limited to “county appropriations for current expenses, supplemental taxes levied for current expenses, [and] state allocations” (p. 22).

**Table 4.2**

*Select Finance (Data CHCCSD 2012–2017)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total operating expenses</td>
<td>$126,514,901</td>
<td>$126,199,998</td>
<td>$128,312,703</td>
<td>$128,991,814</td>
<td>$131,686,132</td>
</tr>
<tr>
<td>Per pupil expenditures</td>
<td>$10,445</td>
<td>$10,385</td>
<td>$10,610</td>
<td>$10,669</td>
<td>$10,878</td>
</tr>
<tr>
<td>Instructional support services (total)</td>
<td>$2,583,078</td>
<td>$2,539,319</td>
<td>$2,980,688</td>
<td>$3,236,653</td>
<td>$3,147,258</td>
</tr>
<tr>
<td>Science kit services (actual)</td>
<td>$200,830</td>
<td>$210,516</td>
<td>$193,530</td>
<td>$194,264</td>
<td>$215,836</td>
</tr>
<tr>
<td>Science kit cost per elementary student (average)</td>
<td>$37</td>
<td>$38</td>
<td>$35</td>
<td>$35</td>
<td>$39</td>
</tr>
</tbody>
</table>

*Note. Adjusted for inflation.*
Table 4.3

*Instructional Support Services Expenditures and Science Kit Services as Percentages of Total Operating Expenses and Total Instructional Support Services Expenditures*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional support services (percentage of total operating expenses)</td>
<td>2.04%</td>
<td>2.01%</td>
<td>2.32%</td>
<td>2.51%</td>
<td>2.39%</td>
</tr>
<tr>
<td>Science kit services (percentage of instructional support services total expenses)</td>
<td>7.77%</td>
<td>8.29%</td>
<td>6.49%</td>
<td>6.00%</td>
<td>6.86%</td>
</tr>
</tbody>
</table>

*Note.* Adjusted for inflation.

As illustrated in Table 4.2, the CHCCSD spent between $126,500,000 and $132,000,000 annually in each of the academic/fiscal years from 2012 through 2017 when adjusted per year for inflation. Contextually, the district was facing the impacts of the Great Recession, eliminating approximately $8,000,000 in expenditures between 2009 and 2012 while absorbing over $4.5 million in mandated cost increases over the same period of time (CHCCSs, 2013). Annual increases in district expenditures between 2012 and 2017 coincided with a rebounding within and likewise net positive increase in annual revenue from local, state, and federal sources.

*CHCCSD Instructional Planning Team: Science.* It is important to note that the Science Coordinator’s work extended beyond elementary science education, associated curriculum work, and elementary science kits. In particular, the 2014–2015 school year saw the start of the Science Coordinator’s regular meetings with the district’s Instructional Planning Team, consisting of representatives from each of four middle and four high schools. This included a biology teacher from each high school and one middle school science teacher (per Grades 6, 7, and 8) from each middle school, for a total of 16 Instructional Planning Team members.

The primary goal for this team was to design a unified, consistent curriculum across each secondary school within the district. The work of 2014–2015 consisted mainly of information
gathering, assessing the current scope and sequence in place at each school, and beginning the collaborative work of aligning said curricula. This team met a total of four times over the course of the academic year.

The primary expense associated with organizing the Instructional Planning Team was dedicated toward substitute teacher costs. These teachers substituted for the Instructional Planning Team members during these four meetings, each of which involved a full day’s professional leave. As adjusted for inflation during the 2014–2015 school year, $2,582 was spent on substitutes for this curriculum planning. Additionally, one meeting was hosted at a venue that required a rental fee of $674, for a total of $3,256 spent on Instructional Planning Team work for the year.

The account code to cover the cost of substitutes (2.5870.003.163.000.207.00) indicates local funds were allocated for these instructional services (school-based support; CHCCSs, 2015a). The 5870 purpose code delineated staff development activities for all instructional areas or when staff development funds were appropriated to schools for direct payments, as here in the case of substitute teacher pay indicated by Program Report Code 003: support personnel. The 000 location code here again applied to district-wide use, and the 207 user code referenced a shared budget used by the district’s Math Coordinator and Science Coordinator. Funds to cover the $685 facility rental fee utilized a similar accounting code structure with the exception of the user code (.312) indicating a general fund utilized for staff development and workshop purposes.

Additionally, the primary expenditure of any school district lies within personnel (salaries and benefits). The district’s Science Coordinator was paid an annual salary of $67,000, and each elementary school was allotted a 0.5 teaching position for a Math/Science Specialist (approximately $26,000 per year). Eight, 2-hour meetings over the course of a year with these
Math/Science Specialists were dedicated to the development of a new science kit implementation model. Approximating an hourly rate of pay for 11 Math/Science Specialists and the Science Coordinator, roughly $3,500 was spent in salary to facilitate the collaborative efforts of science kit revisions.

As discussed in the previous section, local funds were appropriated for the design and implementation of science curriculum. This included approximately $200,000 each year for the implementation of elementary science kits (as determined through the use of archival records and financial data). This amount represented roughly 6% of the Instructional Support Services budget in 2014–2015, and subsequent sections will further examine science kit investments and the intra-district allocation of these resources.

The work of the Science Coordinator exemplified one district’s attempt to create a centralized curriculum model. This was researched by Wiggins and McTighe (2005) as a means to flexibly create a curriculum that is representative of ever-changing state learning standards. In more detail, the common curriculum shared across multiple schools supports the distinct courses of study (by subject and grade; Kelting-Gibson, 2005).

**Systems Theory Analysis.** Functionally, the Instructional Services Division was seeking to create a means for curriculum review by funding the development of a district-wide, common curriculum. The historic desire to assess the success of a designed curriculum (Clune, 1994) led to the creation of common assessments to be used in district-wide data analysis. Establishing a common science kit rotation allowed for the common sequencing of this district-wide curriculum. This standardization remains a consistent focus within education (Au, 2011). However, this alone cannot prove causality in the broader system of curriculum development.
A series of previously existing factors within the CHCCSD impacted the development of the elementary science curriculum. As investigated in Research Question 3, cultural perspectives, preexisting curricula in other content areas, and personal preference among individual teachers influenced the ultimate development of the common curriculum. These decisions had significant and long-term financial implications for the district. Along with this chapter’s additional findings, longitudinal funding of elementary science curriculum will be further discussed in Chapter 5.

Figure 4.4 details the interactions between key personnel in the development and implementation of elementary science curriculum. Eleven building principals directly supervise teachers in kindergarten through fifth grade. These grade-level teachers utilize science kits as the primary resource in delivering science content to students. Math/Science Specialists work directly with teachers in this delivery and are also supervised by building principals. The Math/Science Specialists also work with the district’s Science Coordinator to develop science curriculum and revised science kit models. The Science Coordinator also took into consideration feedback received from building principals.
Figure 4.4

A Variety of Personnel Interact With Each Other in the Delivery of Science Kits to Elementary Students

Research Question 2a: To What Extent Do School Districts Invest in These Efforts Vis-à-Vis Science Kits?

Similar to the timeline detailed in the previous section, archived financial records, meeting agendas, documents, and correspondence between 2015 and 2017 were analyzed. Qualitative and quantitative data were analyzed through the lens of science kits and their implementation. This section details the CHCCSD’s multiyear investment into science kits.

Here again, memo-writing was utilized to compile a chronological narrative. This narrative relies upon my memo-writing to connect other findings to historical influences within
the studied district. Four criteria were used in reviewing historical documents. First, each document was assessed for authenticity (soundness and authorship). Second, the accuracy of each document was assessed to determine credibility. Documents were then reviewed for representativeness (were the selected documents representative of the environment influencing the study?). Last, documents were assessed for meaning. As each document was interpreted, literal and quantitative interpretations were analyzed as well as any qualitative significance in words, terms, and/or imagery. I found within these documents the themes of consistency as well as the need for assessments to determine the effectiveness of curriculum implementation. This section concludes with a comparison of findings to the literature presented in Chapter 2.

**Key Dates and Themes.** In 2014, the district also hired a STEM Coordinator. In the August 29, 2014 meeting between the Science and STEM Coordinators, initial conversations began regarding science kits, who oversees them and their use, and next steps to determine/assess their implementation and fidelity to state standards. The coordinators’ combined abilities to meet the curricular needs of individual schools was also discussed, with a timeline for regular follow-up meetings between the coordinators established.

In a follow-up to the August 29, 2014 meeting, the STEM and Science Coordinators met with other coordinators (Math, Technology, and Career/Technical Education) on October 15, 2014. This combination of central office administrators discussed the field of STEM and current states of implementation (to include the elementary level), and proposed next steps for STEM expansion in K–12 classrooms. Science kits were discussed as a supplemental resource to this broader field.

On February 11, 2016, the Science Coordinator called a representative of ECA Science Kit Services. During this phone call, the Science Coordinator requested a quote for the costs
associated with purchasing additional science kit materials. These materials would increase the
district’s current inventory for each kit to potentially allow each grade level at each elementary
school to receive the same science kit at the same time. In a follow-up email, a quote for an
inflation-adjusted $24,086 was received.

On February 26, 2016, the Science Coordinator met with the Assistant Superintendent for
Instructional Services to present two curriculum models and timelines for expanding the
district’s science kit rotation. Each timeline detailed the creation of in-house units to coincide
with a decreased dependency on ECA Science Kit Services with the ultimate goal of maintaining
kits entirely within the district. The key difference across each of the proposals was the pace at
which the contract with ECA was terminated over a possible 4 years.

Throughout the start of the Science Coordinator’s tenure in the Instructional Services
Division, curricular alignment, cross-disciplinary opportunities, and vertical alignment were
consistently identified as driving factors in the development of elementary school curriculum.
The February meeting between the Science Coordinator and Assistant Superintendent captured
these themes in the pursuit of common, elementary science kit implementation across the district.
Table 4.4 outlines each option presented by the Science Coordinator, related costs, and the
corresponding pace of curriculum development.
Table 4.4

**Summary of 2016 Science Kit Revision Proposal**

<table>
<thead>
<tr>
<th>Option</th>
<th>Description/highlights</th>
<th>Total cost paid to ECA over 4 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Maintains current model</td>
<td>$805,326 ($201,331 per year)</td>
</tr>
<tr>
<td></td>
<td>Continues contract with ECA Instructional Services to maintain science kit inventory</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Gradual development of district-created units to supplement or replace science kits</td>
<td>Year 1: $201,331</td>
</tr>
<tr>
<td></td>
<td>No additional up-front costs</td>
<td>Year 2: $197,051</td>
</tr>
<tr>
<td></td>
<td>Longest time to reduce dependency on ECA Instructional Services</td>
<td>Year 3: $96,289</td>
</tr>
<tr>
<td></td>
<td>Does not implement common science kits across elementary schools until 2017-2018 school year</td>
<td>Year 4: $0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL: $493,671</td>
</tr>
<tr>
<td>C</td>
<td>Accelerated creation of district science units</td>
<td>Year 1: $225,417</td>
</tr>
<tr>
<td></td>
<td>Reduces contract with ECA Instructional Services at accelerated pace</td>
<td>Year 2: $197,051</td>
</tr>
<tr>
<td></td>
<td>Implements common science units across elementary schools in 2016-2017</td>
<td>Year 3: $75,366</td>
</tr>
<tr>
<td></td>
<td>Requires the up-front purchase of $24,086 in materials for additional inventory to be distributed across schools by ECA</td>
<td>Year 4: $0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL: $497,834</td>
</tr>
</tbody>
</table>

*Note: Adjusted for inflation.*

In reviewing the options described in Table 4.4, the Assistant Superintendent opted to pursue Option C. The additional, inflation-adjusted $24,086 in expenses was approved so that materials and equipment could be purchased. This would round out the district’s current science kit inventory to allow ECA Instructional Services to deliver the same kit at the same time to corresponding grade levels across all 11 elementary schools. This plan also required the development of 10 additional units to address standards absent from the current science kit inventory. It was agreed upon that 10–12 units were to be generated each year through the 2018–2019 school year to reduce the dependence on science kits for curriculum. A goal was set to have a district-developed science curriculum in place for the 2019–2020 school year. This would allow the $201,331 (adjusted for inflation) that was currently dedicated each year to the ECA contract to be reallocated in support of the newly designed curriculum.
In 2015, elementary science education in the district relied heavily on standalone science kits. These kits, delivered quarterly to each classroom in kindergarten through fifth grade, provided lesson plans to coincide with hands-on activities. All of the materials required to conduct these lessons were included within the kit, and the district contracted with ECA Science Kit Services to collect kits at the end of each quarter, restock consumables, replace damaged materials, and redeliver kits to the next school in a predetermined rotation. In the 2015–2016 fiscal year, the district allocated over $203,000 for the contract with ECA Science Kit Services when adjusted for inflation.

The CHCCS’s Approved Budget detailed expansion requests in several priority areas. Inflation-adjusted figures include more than $144,000 in professional development funding to train teaching staff in the design and implementation of a curriculum focused on learning goals, meaningful assessments to measure student progress, and “meaningful and engaging lessons designed to make students think and problem solve” (CHCCS, 2015, pp. 1–3). Additionally, $28,930 was requested to purchase exemplary units to supplement teacher-created units that were to be designed throughout the 2013–2014 and 2014–2015 school years. $18,406 was also requested to fund an increase in the contractual costs associated with the district’s science kit services. A total expansion request of $725,958 was submitted to the Board of Education for Approval.

By pursuing the accelerated creation of district science units, the Assistant Superintendent began a gradual reduction in dependency on ECA Instructional Services for science kit maintenance; however, this required the additional up-front cost of $24,086 to purchase more materials. This cost reinforced the district’s ongoing commitment to science. More importantly, this one-time cost highlighted the district’s desire to pursue a common
elementary science curriculum that is identical across 11 elementary schools with regard to sequencing (each grade level in each building would receive the same kits at the same times). Hallmarks of this common curriculum included common assessments to be reviewed regularly by intra-district colleagues. Data provided by these assessments would not only allow teachers to evaluate student mastery, but spark additional collaboration in assessing the effectiveness of instruction, instructional materials, and ways of improving both.

The ease of use advertised by science kit manufacturers seeks to alleviate the challenges facing elementary school teachers when tasked with teaching science. As described by Davis and Smithey (2009), elementary school teachers in the CHCCSD teach multiple subject areas. North Carolina science standards also cover a wide range of topics across multiple strands (life, physical, and earth sciences). The implementation of science kits in the CHCCSD provided teachers with the benefits reported by Rennie et al. (2010): an increase in a teacher’s science knowledge and confidence, and the increased use of inquiry-based instruction. However, Blanchard et al. (2013) described the difficulties in assessing science kit effectiveness, and this was subsequently explored through Research Question 4.

**Systems Theory Analysis.** The time series analysis provided above further develops the channels of communication between key stakeholders and their roles within the CHCCSD. The Assistant Superintendent, Science Coordinator, Math/Science Specialists, Principals, and Teachers all interacted to establish long-range curriculum plans for elementary science. Factors such as funding were considered along with the regular collaboration with ECA Instructional Services.

The work of the Science Coordinator began with looking at science kits through a longitudinal lens. This longitudinal review began to incorporate time delays such as the
development of district-created curriculum, the acquisition of additional materials, and Board
approval for additional funds. Beginning to shift the science kit model away from reactive
behavior (having science kits that drive curriculum) supports the district’s ability to examine and
predict patterns instead of maintaining a singular focus on units and kits. Nevertheless, it
remained clear that the materials, teacher guides, and sequencing of the provided elementary
science kits maintained the biggest influence in elementary science curriculum.

**Research Question 2b: How Are These Expenditures Allocated Across Schools Within a
District?**

Further review of archived financial records, meetings agendas, and correspondence
explored resource allocations across schools within the CHCCSD. This section details the final
science kit revisions proposed for the district in 2017. I first outline the steps taken to establish a
new science kit rotation before, and then review the per student expenditures on science kit
implementation across 11 elementary schools.

The chronological narrative was developed from my memo-writing, which connected
district finances to intra-district curriculum development and implementation. Within financial
records and district demographics, spending discrepancies were highlighted across the district
and are discussed in this section’s findings. A comparison of these findings to the research base
concludes the section with an analysis of equity and adequacy

**Key Dates and Themes.** On March 27, 2015, a team consisting of classroom teachers,
the building Math & Science Specialist, and school administrators at one of the 11 elementary
schools in the CHCCSD established a year-long scope and sequence of aligned social studies and
science content standards. These were captured within a “Year-at-a-Glance” document which
utilized ELA standards as the foundation. The school is one of two dual-language immersion
schools within the district. The social studies and science standards were integrated, as illustrated within curricular documents, to support and align with the time-intensive study of the Mandarin language. The scope and sequence also detailed the correlation of each science kit to North Carolina science standards.

On November 17, 2015, a detailed science kit inventory was compiled by the Science Coordinator. With historical data provided by ECA Educational Services, a document was generated that organized science kits by grade level and title. Current district-owned quantities were provided along with a chronological listing of the dates on which each kit was acquired and added to the district’s inventory. Each grade level was associated with three kits (kindergarten and Grade 1) or four kits (Grades 2–5). This information was solicited by the Science Coordinator to assess kit inventory needs for a stated goal of acquiring additional inventory to allow each grade level across 11 elementary schools to engage the same kits at the same times.

As referenced previously, the Science Coordinator solicited additional funds through a meeting with the Assistant Superintendent for Instructional Services in February of 2016. These funds supported a timeline to reduce the district’s reliance upon ECA Science Kit Services. An additional $24,086 (adjusted for inflation) in expenses was approved so that materials and equipment could be purchased. Plans to generate district-created units of study coincided with a 2019–2020 target for a district-developed science curriculum.

On April 4, 2016, the Science Coordinator hosted a 2-hour meeting (meeting six of eight for the school year) with Math/Science Specialists. The primary agenda items involved reviewing a near-final draft of the science kit rotation schedule. This draft is depicted below in Table 4.5. Slight changes to the previous draft were discussed. In particular, the Science Coordinator shared highlights of the meetings held with dual-language schools and their
administrators and Math/Science Specialists. The rationale for maintaining a static scope and sequence at these buildings was shared and discussed. Math/Science Specialists also began archiving current units and resources in use that supplement the current science kits.

Table 4.5

April 4, 2016 Draft of CHCCSD Elementary Science Kit Rotation

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quarter 1</th>
<th>Quarter 2</th>
<th>Quarter 3</th>
<th>Quarter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td>Wood &amp; Paper</td>
<td>Wood &amp; Paper</td>
<td>Weather</td>
<td>Animals 2x2</td>
</tr>
<tr>
<td>1</td>
<td>Pebbles, Sand, &amp; Silt</td>
<td>Balance &amp; Motion</td>
<td>Needs of Living Org</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Air &amp; Weather</td>
<td>Sound</td>
<td>States of Matter</td>
<td>Insects</td>
</tr>
<tr>
<td>3</td>
<td>Matter &amp; Energy</td>
<td>Human Body</td>
<td>Earth, Moon, &amp; Sun</td>
<td>Plant Growth &amp; Dev.</td>
</tr>
<tr>
<td>4</td>
<td>Landforms</td>
<td>Rocks &amp; Minerals</td>
<td>Magnetism &amp; Elect</td>
<td>Anim Behav &amp; Adapt</td>
</tr>
<tr>
<td>5</td>
<td>Motion &amp; Design</td>
<td>Living Systems</td>
<td>Ecosystems</td>
<td>Weather Forecasting</td>
</tr>
</tbody>
</table>

During the penultimate meeting with Math/Science Specialists for the 2015–2016 school year (May 2, 2016), the Science Coordinator facilitated unit planning for parts of the elementary science curricula designed to supplement the science kit rotation. Regarding the kit rotation, feedback from each building (collected using a March 2016 survey) was discussed regarding a now-final rotation schedule. It was generally agreed upon that having two of the 11 elementary schools misaligned at a few points in the scope and sequence would be acceptable. Therefore, overlap and cross-curricular planning with social studies and ELA units began. One meeting participant suggested an additional change to the sequence. The Science Coordinator suggested (and the majority of the team agreed) that pursuing the current draft in the 2016–2017 school year was apropos. The team agreed to move forward with the current rotation schedule draft, collect feedback, and remain open to future changes if necessary. In addition to discussing unit
planning, the team discussed possible website additions, parent/family documents, and other literature that could publicize and detail the elementary science curriculum.

On June 6, 2016, the final meeting with Math/Science Specialists for the academic year took place. During this meeting, the Science Coordinator hosted a discussion regarding the kit rotation, supplementary resources, and unit planning. A new agenda item focused on in-building teacher support and the importance of communicating the year’s work to elementary administrators, teachers, and staff. Also occurring on this date, the Science Coordinator finalized a curriculum document for parents. This K–5 science document presented a “Year-at-a-Glance” that communicated a yearlong scope and sequence of science curricula at the elementary grade levels. Each grade level was attached to corresponding units and, where applicable, science kits. These are then linked to corresponding science standards as labeled by strands (Earth, physical, and life sciences).

A similar overview was provided to elementary school principals. In addition to the parent-targeted information, the scope and sequence information for principals opened with an overview of the year’s curriculum planning work and the rationale behind the new science kit rotation. This memorandum is provided in Appendix C. Instructional resources were also provided along with a preview of the 5-year plan to reduce the district’s reliance on ECA Instructional Services. Overarching themes from this section’s narrative timeline will now be detailed.

The annual expenditures devoted to science kit delivery to each of the district’s 11 elementary schools were allocated proportionately to the number of kits needed by each school. Rather than an equal distribution of kits (each school receiving the same number of a specific kit), quantities were based on the number of science classes being taught in each building.
Previous research suggests that a variety of fiscal factors impact student outcomes (Greene et al., 2007), and an analysis of per-pupil spending on science kits was conducted.

Table 4.6 details the number of science kits allocated for each school in the 2016–2017 school year. The number of students who attended each building is also provided, along with the per pupil cost of science kit implementation for the given school building. This cost, when adjusted for inflation, ranged from $28 to $42 per student for the year. School size, in addition to the delivery model of science kit instruction, heavily impacted this wide range of per pupil costs. This chapter’s final section details organizational and cultural factors within the district that may impact funding, as previously researched by Hanushek (2012).

**Table 4.6**

2016–2017 Science Kit Distribution Across 11 Elementary Schools and Per Pupil Expenditure for Science Kit

<table>
<thead>
<tr>
<th>School Name</th>
<th>Number of kits received</th>
<th>Dollars spent for science kits</th>
<th>Number of students</th>
<th>Per student expenditure for science kits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrboro Elementary</td>
<td>24</td>
<td>$20,314</td>
<td>738</td>
<td>$28</td>
</tr>
<tr>
<td>Ephesus Elementary</td>
<td>19</td>
<td>$16,082</td>
<td>396</td>
<td>$41</td>
</tr>
<tr>
<td>Estes Hills Elementary</td>
<td>23</td>
<td>$19,468</td>
<td>765</td>
<td>$25</td>
</tr>
<tr>
<td>Glenwood Elementary</td>
<td>21</td>
<td>$17,775</td>
<td>483</td>
<td>$37</td>
</tr>
<tr>
<td>FPG Elementary</td>
<td>23</td>
<td>$19,468</td>
<td>578</td>
<td>$34</td>
</tr>
<tr>
<td>McDougle Elementary</td>
<td>22</td>
<td>$18,621</td>
<td>511</td>
<td>$36</td>
</tr>
<tr>
<td>Morris Grove Elementary</td>
<td>25</td>
<td>$21,160</td>
<td>545</td>
<td>$39</td>
</tr>
<tr>
<td>Northside Elementary</td>
<td>25</td>
<td>$21,160</td>
<td>499</td>
<td>$42</td>
</tr>
<tr>
<td>Rashkis Elementary</td>
<td>25</td>
<td>$21,160</td>
<td>502</td>
<td>$42</td>
</tr>
<tr>
<td>Scroggs Elementary</td>
<td>23</td>
<td>$19,468</td>
<td>508</td>
<td>$38</td>
</tr>
<tr>
<td>Seawell Elementary</td>
<td>25</td>
<td>$21,160</td>
<td>549</td>
<td>$39</td>
</tr>
</tbody>
</table>

*Note. Adjusted for inflation.*
The Science Coordinator met regularly with various stakeholders throughout the 2015–2016 school year to investigate science kit use, collect feedback from schools and staff, and draft responsive changes to the district’s use of science kits across 11 elementary school buildings. Historical use of these kits in cross-disciplinary curricula that had previously been established in at least two elementary buildings guided a significant portion of the new science kit rotations. These factors will be explored in subsequent sections.

Each elementary building maintained one of two different delivery models for science kit-based instruction. In most of the elementary schools, fifth-grade science was taught by one teacher alone in a departmentalized manner. For example, a fifth-grade team of four teachers might have a dedicated science teacher who taught science to the building’s 100 fifth graders, while another teacher taught math for the grade level, and so on for the remaining subject areas. In contrast, many other grade levels would have each individual teacher teach all subject areas. The different delivery models often impacted science kit cost. In the departmentalized model, one classroom set of lab equipment would suffice as students rotated through science class throughout the day.

Variations in curriculum delivery make it difficult to assess curriculum efficacy (Brighouse, 2004). Furthermore, this section reinforces Macedo’s (2013) claim that research into educational adequacy must consider policy reform and the educational theory applied to curriculum. Table 4.6 signifies inequitable finance distributions when utilizing a broad definition of school finance equity: equal treatment for equally treated children (Springer et al., 2009). The 50% per pupil cost difference between the lowest and highest spending schools (per pupil) cannot solely be attributed to school size. The following section highlights the district’s focus on operationalized consistency as one driving principle in the use of science kits in the CHCCSD.
**Systems Theory Analysis.** This section explores the dynamic systems at play in elementary science curriculum development. The time series analysis shifts focus away from singular events to trends and patterns, such as the science kit model used in each school, dual-language implementation, and scope and sequence of kit use across 11 elementary schools. These various systems were framed as the cause by which interactions self-generate curriculum implementation.

The historical momentum of science kit use in the CHCCSD routinely impacted the overall science curriculum at the elementary level. The Instructional Services Division was reluctant to pursue major delivery changes to the use of science kits. Opposing factors to curriculum alignment included associated costs, the time needed to redesign a calendar of implementation, and a perceived reluctance from teaching staff to change the overall scope and sequence of their curricula (beyond science). A desire to maintain the “status quo” and business as usual within each building was documented in meeting notes.

Additional historical factors within the district were noted as school-by-school expenditures on science kits were researched. The apparent status quo within two distinct teaching models accounted for significant differences and variability in per pupil spending. School-based teacher and staff feedback are here documented as a guiding factor in the design of science kit delivery models. Figure 4.5 continues to expand the “big picture” analysis of systems driving curriculum development and implementation. In the final two sections of this chapter, a feedback loop is highlighted as part of a system designed to continually improve the elementary science curriculum.
Figure 4.5

Historical Factors Interact with Funding Models and Science Kit Use in the Design and Implementation of Curriculum; A Desire to Maintain the Status Quo Inhibits Change to Current Systems

Research Question 3: What Guiding Principles or District Goals Influence the Design of Curriculum?

In focusing on the revision of science kit implementation in the CHCCSD, data were collected from each of 12 meetings held between the district’s Science Coordinator and Math/Science Specialists. Documents included meeting agendas, notes, and correspondence
between these stakeholders as well as building and district-level administrators. Data suggested a primary focus of curriculum alignment across the 11 elementary schools.

This combination of qualitative and quantitative data was reviewed in a nonobtrusive manner to craft the following narrative. Memos were written along with dates and cross-referenced with other memos and data of relevance to document connections and themes. A robust overview of the principles influencing curriculum design is described within a span of time ranging from 2015 to 2016.

**Key Dates and Themes.** On June 12, 2015, prior to the start of the 2015–2016 academic year, the science coordinator distributed a copy of the CHCCSD Blueprint for Curriculum Design to members of the Instructional Planning Team, as well as Math/Science Specialists. Authored by Jay McTighe and Grant Wiggins, this document highlighted Understanding by Design (UbD) as a blueprint for curriculum design with elements that included transfer goals, skills, and the use of standards as a foundation. Curriculum was broken down within the document into programs, courses, units, and lessons.

On June 17, 2015, the Science Coordinator received a Science Kit Rotation Schedule via email from ECA Educational Services. This same schedule was provided each year to Math/Science Specialists, school administrators, and teachers. Organized by school, grade level, and unit, the document grouped the district’s 11 elementary schools into one of four cohorts (labeled A, B, C, and D). Each cohort was then assigned a rotation schedule by which science kits were received. The units and kits were identified by grade level and title. Delivery dates for each kit were listed, along with pickup dates for kits to return to ECA for refurbishment and the replenishing of any consumable materials. The number of kits owned by the district were listed, along with the number in use by each rotation (each school had the corresponding number of
teachers/classrooms provided per grade level). Table 4.7 details an excerpt of the information provided.

Table 4.7

Sample Science Kit Rotation Schedule: Grade 2, 2015–2016

<table>
<thead>
<tr>
<th>School</th>
<th># of Teachers</th>
<th>Unit: Insects</th>
<th>Unit: Air &amp; weather</th>
<th>Unit: States of matter</th>
<th>Unit: Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrboro</td>
<td>4</td>
<td>D</td>
<td>A</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>Ephesus</td>
<td>3</td>
<td>A</td>
<td>C</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>Estes Hills</td>
<td>4</td>
<td>A</td>
<td>C</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>Glenwood</td>
<td>3</td>
<td>A</td>
<td>C</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>FPG</td>
<td>5</td>
<td>D</td>
<td>A</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>McDougle</td>
<td>3</td>
<td>B</td>
<td>D</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>Morris Grove</td>
<td>4</td>
<td>D</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Northside</td>
<td>4</td>
<td>B</td>
<td>D</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>Rashkis</td>
<td>5</td>
<td>B</td>
<td>D</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>Scroggs</td>
<td>4</td>
<td>C</td>
<td>B</td>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td>Seawell</td>
<td>4</td>
<td>C</td>
<td>B</td>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td>Max Qty Kits in Use</td>
<td></td>
<td>13</td>
<td>13</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Client Owned</td>
<td></td>
<td>15</td>
<td>15</td>
<td>16</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TIME BLOCK CODES</th>
<th>Start date</th>
<th>Pickup date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8/26/15</td>
<td>10/16/15</td>
</tr>
<tr>
<td>B</td>
<td>10/29/15</td>
<td>1/8/16</td>
</tr>
<tr>
<td>C</td>
<td>1/25/16</td>
<td>3/21/16</td>
</tr>
<tr>
<td>D</td>
<td>4/7/16</td>
<td>1/2/16</td>
</tr>
</tbody>
</table>

On September 10, 2015, the Science Coordinator attended a meeting with the Executive Director of Curriculum and Instruction (central office administrator within the Instructional Services Division and the Science Coordinator’s direct supervisor). This beginning-of-year meeting addressed district curriculum work, proposed future meeting dates, and a brief review of
the research base for the year’s work. In preparation for this meeting, the Science Coordinator completed a beginning-of-year document that detailed current work and future endeavors for the 2015–2016 school year. The document described scope and sequence, curriculum planning currently underway, the proposed work for aligning science kit rotations, and the connections of these two endeavors with district initiatives and goals.

On September 28, 2015, the Science Coordinator hosted his first meeting with the 11 district Math/Science Specialists (one from each of the district’s 11 elementary schools). Among other topics, the meeting’s agenda included a review of North Carolina science standards and beginning a discussion regarding a common curriculum across elementary schools, including a common science kit rotation. This September meeting was the first of eight total meetings with the group.

The Science Coordinator attended a monthly meeting of elementary school principals on September 29, 2015. At this meeting, the Science Coordinator provided an update regarding current and future work to be conducted with the assistance of Math/Science Specialists. This presentation detailed the current examination of science kit implementation, including an exploratory correlation to state standards. Additionally, plans to incorporate literacy standards within a multidisciplinary science curriculum was discussed. The presentation concluded with an overview of the future goal of sequencing a broader, vertically aligned science curriculum. This curriculum accompanied the redesign of the district’s approach to science kit usage. As the meeting ended, the Science Coordinator invited building principals to contact him with additional needs, questions, or concerns.

On October 20, 2015, the principal of Glenwood Elementary School hosted a meeting with the Science Coordinator to discuss proposed curriculum work. Previously, this
administrator had also served as the district’s Science Coordinator. She reviewed the history of the position and prior work within the district. Glenwood Elementary School maintains one of two dual-language programs within the district. As such, K–5 curriculum was not only mapped out for the school, but deliberately cross-curricular so that instructional practices that include language modifications, vocabulary incorporation, and literacy instruction are tightly aligned throughout each grade level. A “Year-at-a-Glance” document was shared with the Science Coordinator; this document detailed the current science kit rotation, and how corresponding units interfaced with unit and lesson arcs across each grade level. The principal requested that Glenwood’s scope and sequence be referenced in drafting changes to the science kit rotation.

The Science Coordinator hosted the second meeting of Math/Science Specialists for the school year on November 2, 2015. The 3-hour meeting reviewed and built upon information from the September meeting in addition to introducing additional topics. These included, but were not limited to literacy in science, science fairs, and parent literature/information for community consumption. Most notably, a deeper conversation regarding science kit implementation was pursued by the group. This discussion focused on the current rotation and its efficacy.

On November 15, 2015, the Science Coordinator distributed a survey to all elementary schools within the district. This survey was designed to collect feedback regarding the current science kit inventory, implementation, and rotation schedule and was shared with each classroom teacher. Regarding each science kit, a ratings scale was developed for teachers to rate the degree to which they agreed or disagreed with the following queries: (a) whether or not the kit met curriculum/standards requirements, and (b) whether or not the kit provided a worthwhile learning
experience for students. Teachers were also asked if they used the kits (yes or no) and invited to provide open-ended feedback.

The Science Coordinator hosted a 1.5-hour meeting with Math/Science Specialists (meeting 3 of 8) on December 7, 2015. New agenda items included the team’s recent collaboration with middle school colleagues (regarding vertical alignment) and a synopsis of professional development opportunities, such as the attendance of several team members at the North Carolina Science Teachers Association annual conference. The primary focus of the meeting was elementary science kits. The kit rotation schedule was reviewed along with the information collected in the science kit survey that was previously distributed to elementary school teachers. Several issues were raised and addressed:

- Each kit was accompanied by a printed teacher’s manual. This guide offered detailed lesson plans and instructions for the kit’s implementation. Planning for upcoming units (sequencing, pacing, and integration in other content areas) was often difficult without these manuals in hand. Previously proposed solutions included (a) purchasing digital copies of these manuals, or (b) sending teachers the manuals for the current unit of study and next unit of study, requiring the additional purchase of roughly one additional manual per unit per school. These proposed solutions were denied due to budget constraints.

- The primary barrier to a common, district-wide science curriculum was the science kit rotation. Only three schools ever shared the same kits at the same time.

- It was also noted that there were significant gaps in content coverage with the current science kit rotation. For example, there was no science kit in the current
rotation that addresses heat and energy content within the fifth-grade science standards.

On February 1, 2016, Math/Science Specialists met with the Science Coordinator and began discussing revisions to the science kit model. In particular, several kit rotations were drafted with the rationale, merits, and shortcomings of each discussed among the team. This meeting lasted 1.5 hours. At the conclusion of this meeting, an initial draft of the common, district-wide science kit rotation was recorded. This draft is reflected in Table 4.8.

Table 4.8

*February 1, 2016 Draft of CHCCSD Elementary Science Kit Rotation*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quarter 1</th>
<th>Quarter 2</th>
<th>Quarter 3</th>
<th>Quarter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td>Wood &amp; Paper</td>
<td>Weather</td>
<td>Animals 2x2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Pebbles, Sand, &amp; Silt</td>
<td>Balance &amp; Motion</td>
<td>Needs of Living Org</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Air &amp; Weather</td>
<td>Sound</td>
<td>States of Matter</td>
<td>Insects</td>
</tr>
<tr>
<td>3</td>
<td>Matter &amp; Energy</td>
<td>Human Body</td>
<td>Earth, Moon, &amp; Sun</td>
<td>Plant Growth &amp; Dev.</td>
</tr>
<tr>
<td>4</td>
<td>Landforms</td>
<td>Magnetism &amp; Elect</td>
<td>Rocks &amp; Minerals</td>
<td>Anim Behav &amp; Adapt</td>
</tr>
<tr>
<td>5</td>
<td>Motion &amp; Design</td>
<td>Living Systems</td>
<td>Ecosystems</td>
<td>Weather Forecasting</td>
</tr>
</tbody>
</table>

*Systems Theory Analysis.* Several factors were consistently noted in my review of the data. Systems analysis expanded the boundaries of my data review to understand other perspectives and structures involved within the communication and development of curriculum. The CHCCSD pursued curriculum redesign by considering the following principles:

- the backward design of curriculum whereby standards are utilized as the foundation for student understanding;
- a desire for teachers to develop a unique, consistent curriculum for the district;
• a reliance upon stakeholder groups such as Instructional Planning Teams and Math/Science Specialists to inform the process of curriculum design;

• the district’s Long Range Plan, its guiding principles, and the Instructional Services Division’s long-term support of the district’s instructional goals;

• an adherence to previously established practices (such as the district’s longstanding dual language curriculum); and

• establishing vertical alignment for more uniform, K–12 curricula.

These common themes are summarized at the conclusion of this chapter. The previously mentioned relationship between funding, historical influences, and district guiding principles continue to be evident in the redesign of an elementary science curriculum.

The yearlong process to redesign elementary science curriculum exemplifies some of the challenges facing elementary school teachers when tasked with teaching science. These were described by Davis and Smithy in 2009. First, elementary teachers must often teach multiple subject areas. Second, elementary science standards often cover a broad range of topics in each grade level. Last, teacher preparation programs rarely cover more than introductory level science content.

Feedback from Math/Science Specialists reinforced a focus on inquiry-based, hands-on opportunities to teach the practices of doing science. Walker and Warfa (2017) described these approaches as engaging and collaborative in teaching transferable skills. Teacher survey data communicated an appreciation for science kits as easy-to-use approximations of curriculum with clear content for students to learn. This was similar to the findings of Steiner et al. (2017) and reiterated the notion that many school districts are implementing science kits in elementary schools (Rennie et al., 2010). However, the use of science kits posed the following challenges in
the CHCCSD in 2015–2016. First, some learning standards were left unaddressed by the use of science kits. Second, the continued use of science kits required an investment of over $200,000. Finally, the model in place prohibited the implementation of a common curriculum.

In answering the research question posed here, I began documenting the district’s trend towards common curricula across grade bands. The pursuit of a common elementary science scope and sequence dictated the renewal of the science kit delivery timeline as well as the spending of additional funds to make a new timeline possible. As will be discussed in subsequent sections, a system of accountability was proposed to monitor the effectiveness of implementation. Though not specifically tied to expenditures (i.e. seeking a return on investment), accountability measures would allow the district to measure the effectiveness of science kits and target intervention and remediation where necessary. Accountability within the system also allows for a feedback loop to support continuous improvement. Figure 4.6 illustrates the relationships between curriculum design, funding, historical factors, instructional materials, accountability, and district guiding principles.
Research Question 4: What Longitudinal Data Support the Implementation of Curriculum?

As outlined in Chapter 3, the previous section’s research methods provided the data for my subsequent research into the longitudinal data used in the design and implementation of curriculum. In addition to archived documents previously referenced, this section reviewed the data collected from a 2015 Science Kit Survey. This survey was distributed to elementary
classroom teachers within the CHCCS and collected feedback regarding the district’s current use of science kits. After a descriptive timeline is provided, key themes from the Science Kit Survey are reported along with direct feedback provided by Math/Science Specialists. An overview of the district’s implementation plan is provided. This highlights building-based requirements to collect data regarding the new science kit rotation.

**Key Dates and Themes.** On, December 16, 2015, the Science Coordinator completed for the Executive Director of Curriculum and Instruction a document titled, “Instructional Services Division Mid-Year Check-In.” This document was completed by all content coordinators prior to a meeting of all Instructional Services Division administrators. It reflected upon the Science Coordinator’s current work and previewed upcoming endeavors. Curriculum work progress at elementary, middle, and high school levels was detailed along with the science kit alignment process. In addition, budget and funding needs associated with these endeavors was also reviewed and shared at the meeting.

The Science Coordinator hosted meeting five of eight with Math/Science Specialists on March 7, 2016. The team met for 2 hours to establish a more complete science kit rotation draft. It was shared that the previously stated goal of establishing a common rotation was coming to fruition and would be in place for the 2016–2017 school year. This meant that all schools/grade levels would have the same kit at the same time across the district. The remaining meetings of the year were then utilized to finalize the rotation schedule. The following 5-year implementation plan was shared with the Math/Science Specialists:

- 2016–2017
  - District elementary schools implement common science kit rotation schedule.
Supplemental units are developed/implemented in addition to science kits to cover standards not addressed within science kits.

- **2017–2018**
  o Science kits are revamped in a proposed process to phase them out in favor of district-developed units.
  o Kits are to begin being phased out with the weakest/least relevant kits being removed first.

- **2018–2019**
  o Math/Science Specialists continue developing district-created units.
  o The goal is to have 100% of the scope and sequence developed as unattached to current science kits by the end of the 2018–2019 school year.

- **2019–2020**
  o Elementary schools begin full implementation of a scope and sequence not tied to science kits.
  o 100% of previously allocated funds (for ECA kit refurbishment services) is now designated for unit development and the in-district purchase of supplies, materials, and consumables.

**2015 Science Kit Survey.** In addition to the work pursued by the Math/Science Specialists, the Science Coordinator distributed a survey to elementary teachers. The survey provided an overview of proposed changes to the science kit rotation schedule and its implementation across the district. The draft rotation schedule was shared and survey respondents were invited to provide feedback and submit questions regarding the draft. As a final agenda item, a unit planning template was shared as a preview of unit planning work to be
started over the summer and throughout the 2016–2017 school year. The initial units to be targeted were to be designed to address those science standards not currently addressed in the science kits.

The Science Coordinator and team of Math/Science Specialists had the opportunity to review the results of the science kit survey in early 2016. The data obtained provided classroom teacher feedback regarding the science kits and their implementation. In 2015–2016, there were a total of 255 elementary school teachers receiving science kits in the CHCCS. Twenty-two unique kits were delivered to these K–5 teachers. Survey feedback was received for each of these kits with response participation from each of the 11 elementary schools polled. One-hundred-eighty-three responding teachers rated the degree to which they agreed with several statements (choices provided were strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree). Highlights from the collected data are listed below.

- Of the 183 respondents, 72% found the accompanying teacher resources to be helpful, and 66% of respondents reported feeling comfortable utilizing the science kits.

- Of the 183 respondents, 36% agreed and 36% of respondents strongly agreed that students found respective science kits to be engaging.

- Overall, 62% of respondents found the science kits to be worthwhile learning experiences for elementary science students.

- However, only 50% of the reviewed science kits were rated by teachers as having fulfilled curricular requirements as outlined by the North Carolina Science Standards.
• Of the 183 respondents, 15% reported that they did not use particular science kits. Misalignment to content standards was reported as the most common reason for not using kits. Six teachers reported that kits were not used because their school or grade level had developed their own replacement unit, and one teacher reported that a science kit arrived too late for it to be used properly.

Within the open-ended responses, a variety of feedback was received. Positive anecdotes highlighted ease of use, student engagement, and the kits’ ability to provide hands-on experiences to students. Negative feedback primarily reported various kits’ inabilities to meet grade-level standards. Often, the materials were reportedly adapted to meet class-specific needs or not used at all.

Utilizing this feedback, Math/Science Specialists agreed to begin phasing out particular kits after newly designed science units could be drafted as replacements. The 4-year implementation plan relied heavily on these district-created units to supplement the science kit rotation and then phase particular kits out.

Math/Science Specialist Feedback. The Science Coordinator’s regular meetings with Math/Science Specialists produced impactful feedback regarding the logistics involved in designing a science kit rotation. Much of this feedback benefited from the practical experiences of classroom teachers as they taught the science kits. Examples include, but are not limited to:

• The Weather kit was more suitable for a spring or fall unit. The kit’s accompanying assignments and activities involved outdoor observations that were often more difficult to practically accomplish in colder temperatures. Spring and fall seasons offered more variety in weather patterns and also aligned with severe weather preparedness activities.
• Similarly, kits involving seedlings, plants, and accompanying germination considerations were more suitable for spring months.

• Several science kits were accompanied by living organisms. These insects, fish, and lizards required proper care. Therefore, it was impractical to receive these kits in the second and fourth quarters of the school year when organisms would have to be left alone over winter or spring break.

This feedback played an important role in establishing several units of study in the elementary science scope and sequence. For example, five of six elementary grade levels received a living organisms kit each year. The newly designed rotation schedule ensured that all living organisms were delivered to schools in the fourth quarter of every subsequent school year.

As referenced previously, in 2015, the CHCCSD was one of many school districts implementing science kits in elementary schools. In addition, the district began moving toward self-developed, teacher-created units. My research, particularly the teacher feedback provided in the Science Kit Survey, supported the research of Rennie et al. (2010), who reported the many benefits of science kit usage. These benefits include an increase in teacher comfort and core science content knowledge, increased use of inquiry-based instruction, and consequently, an increase in classroom teacher confidence.

However, many variables are associated with science kits and the evaluation of their effectiveness (Blanchard et al., 2013). Teacher and Math/Science Specialist feedback indicated differences in the frequency of kit usage, fidelity of implementation, and the variety of supplemental materials provided by individual classroom teachers. The district’s development of unit and lesson-planning templates, along with a feedback loop for evaluation of delivery, support a focus on the evaluation of a curriculum’s effectiveness.
**Systems Theory Analysis.** This final section incorporates feedback into the systems model as it addresses policy impacts on curriculum development. Feedback loop thinking moves away from linear and reactive behaviors to circular patterns that analyze broader systems. Figure 4.7 adds teacher feedback as the final sociocultural component within a series of systems influencing the development and implementation of science curriculum within the CHCCSD.

Science kit surveys, direct feedback from Math/Science Specialists, and the formal and informal collaboration of district and school-based administrators influenced final decisions in elementary science kit rotations, assessments, and a long-term plan to supplement and replace the kits as standalone units of study. Both accountability and teacher feedback provide varied opportunities for refinement of curriculum within the system. The interrelatedness of the factors illustrated in Figure 4.7 will be further described in Chapter 5.
Figure 4.7

The Addition of Staff Feedback (From Teachers and Math/Science Specialists) Allows For Continued Refinement of Science Kit Usage Within the Elementary Science Curriculum

Data established clear ties between funding, historical influences, and school district guiding principles on the use of science kits within the elementary science curriculum. Qualitative data also routinely referenced an emphasis on accountability (another district goal) and teacher feedback/input into the curriculum design process. However, there were fewer objective ties between these aspirations and any lasting impact on the science curriculum. Thus, Figure 4.7 identifies these less influential connections with thinner lines.
Common Themes

Instructional Planning Teams

The Science Coordinator began the 2014–2015 school year tasked with the creation of Instructional Planning Teams for middle and high school science courses and the examination of current science kit use at the elementary level. This work began in September with representatives from each of four middle schools and four high schools and continued throughout the remainder of the school year. Concurrently, the Science Coordinator began meeting regularly with other administrators within the Instructional Services Division, building administrators, and various other staff members to collect information regarding the district’s use of elementary science kits.

As noted in the Science Coordinator’s notes from an August 14, 2014 meeting with the Assistant Superintendent for Instructional Services, the district’s focus for the 2014–2015 school year was placed on planning. This overarching theme encompassed the day-to-day unit planning of individual classroom teachers, as well as the broader, unit-based planning as it related to a K–12 science curriculum. A stated goal for the Instructional Services Division was to foster a culture of deliberate planning with a focus on the district’s stated goal of achieving instructional excellence through a growth mindset.

Guiding Principles

In a November 13, 2014 presentation to a meeting of middle and high school Instructional Planning Team members, the Science Coordinator highlighted the district’s guiding principles, as detailed in the CHCCSD’s Long Range Plan (CHCCS, 2014):

- Growth mindset: Through this guiding principle, educators commit to the belief that intelligence is not stagnant. Rather, continuous effort creates and fosters
ability. Within the classroom, instructional practices provide adequate time for learning. Curricula are thus adaptively paced to meet the varying, developmental skill levels of students.

- **Equity:** A focus on equity advocates for relevant curriculum that provides meaningful connections to students’ lives in and out of the classroom. Rigorous instruction and purposeful curricula maintain the goal of eliminating achievement gaps between demographic groups.

- **Commitment and accountability:** The district communicates the responsibility of all stakeholders for the success of the overall Long Range Plan. Curriculum development requires the need for both continuous improvement as well as the appropriate level of oversight of implementation.

- **Professional learning:** Embedded within the teacher’s work year, professional learning maintains an instructional focus, is aligned to the district’s Long Range Plan, and promotes the development of 21st-century learners in both staff and students. Components of the district’s professional learning catalogue highlight instructional and unit/curriculum planning as well as overall connections to the other guiding principles.

- **Collaboration:** School and community partnerships rely on a culture of collaboration, mutual trust, civility, and innovation. These tenets guide curriculum planning and are infused within the work of all other guiding principles.

These guiding principles were highlighted, along with their impact on the design of curriculum and instruction. As a stated goal for the work of the Instructional Planning Team, the
Science Coordinator targeted a district science curriculum that is coherent, guaranteed, and viable.

It was also noted that the district’s language regarding curriculum design was often used interchangeably with unit design (CHCCSs, 2016b). The UbD Framework was often cited as a planning process and structure to guide curriculum, instruction, and assessment (Wiggins & McTighe, 2011).

The same Long Range Plan’s initial foundation was referenced within the work of the Greenhouse Project, a large community event having occurred in 2012 that identified the critical needs of the CHCCSD. The Greenhouse Project established the guiding principles referenced previously. Three themes emerged within documents related to the Greenhouse Project: (a) the need to address and eliminate the district’s achievement gap, (b) the need for quality, job-embedded professional development, and (c) a unifying belief in a growth mindset.

Another component of the district’s plan for designing curriculum involved the use of data to review several factors. These included progress toward unit design and implementation, teacher-based feedback on said units, and the use of district-based assessments within each unit. These formative and summative assessments were proposed to yield data regarding student mastery of content standards, provide a feedback loop for unit design, and offer district-level instructional teams a foundation for discussing their practice: what works, what strengths in instruction and curriculum should be continued, and what strategies need refinement?

In the 2015 Long Range Plan Status Update (CHCCSs, 2015b), the district’s superintendent highlighted key components of work related to curriculum and instruction. Documents related to this work revealed several data-related themes regarding curriculum implementation. For one, common assessments were targeted as a district-wide strategy to
measure the effectiveness of common curricula. In-house and commercial tools were to be designed and/or purchased to assist in benchmarking student progress. Teacher teams were then tasked with implementing these assessments in addition to reviewing data and adjusting instruction as required. These common assessments were scheduled to begin in Fall 2015.

Additionally, a district communication to all administrators and staff highlighted and defined Long Range Plan Strategy 1.5: Teacher Expectations. This document was developed to provide clarity regarding teacher expectations in the following areas: general planning, responsibilities to the school community, and responsibilities to the PLC. Embedded within these expectations was the requirement that all PLCs (grade level and/or subject area) have common unit plans utilizing the UbD template. The district also created a centralized, electronic location to house completed units. These were organized by grade level and subject.

**Collaboration and Flexibility**

In addition to continued work with Instructional Planning Teams in Grades 6–12, the Science Coordinator began an extensive review of science kit usage at the elementary level. This work was previewed by Math/Science Specialists prior to the start of the academic year, as these staff members were relied upon heavily as the district redesigned curriculum and the associated use of science kits.

Math/Science Specialists formally met with the Science Coordinator a total of eight times over the course of the 2015–2016 school year. Their feedback, along with data collected from formal and informal surveys, began a review of the current science kit model. After isolating guiding principles to inform revisions to their use, several rotation drafts were shared with key stakeholders. These groups included classroom teachers and building administrators. The final iteration of the new 2016–2017 science kit rotation was finalized on April 4, 2016.
following 2 months concluding the school year involved publicizing these changes to schools, teachers, and families and beginning the planning work that would ultimately design units to supplement the science kit model.

Much of the anecdotal feedback received expressed concerns regarding elementary science standards not addressed within the science kits. The Science Coordinator’s curriculum-planning work with Math/Science Specialists prioritized those standards in the development of district-created units. Armed with a 4-year implementation plan and a new science kit rotation, the Science Coordinator concluded the year communicating these changes across the district and offering site-based support to administrators and teachers.

During the planning process, the Science Coordinator also met with representatives from two of the district’s 11 elementary schools. These schools, having maintained a deliberately planned, cross-curricular dual-language program, requested that their current rotations remain intact. This request, in which the two dual-language schools maintained a misaligned scope and sequence, was subsequently approved by the Assistant Superintendent. This misalignment impacts three grade levels for a total of seven units (out of 22 total, elementary science units) and can be seen in Tables 4.9 and 4.10.

Table 4.9

*Final Draft of CHCCSD Elementary Science Kit Rotation*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quarter 1</th>
<th>Quarter 2</th>
<th>Quarter 3</th>
<th>Quarter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td>Wood &amp; Paper</td>
<td>Weather</td>
<td>Animals 2x2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Pebbles, Sand, &amp; Silt</td>
<td>Balance &amp; Motion</td>
<td>Needs of Living Org</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Air &amp; Weather</td>
<td>Sound</td>
<td>States of Matter</td>
<td>Insects</td>
</tr>
<tr>
<td>3</td>
<td>Matter &amp; Energy</td>
<td>Human Body</td>
<td>Earth, Moon, &amp; Sun</td>
<td>Plant Growth &amp; Dev.</td>
</tr>
<tr>
<td>4</td>
<td>Landforms</td>
<td>Rocks &amp; Minerals</td>
<td>Magnetism &amp; Elect</td>
<td>Anim Behav &amp; Adapt</td>
</tr>
<tr>
<td>5</td>
<td>Motion &amp; Design</td>
<td>Living Systems</td>
<td>Ecosystems</td>
<td>Weather Forecasting</td>
</tr>
</tbody>
</table>
### Table 4.10

**CHCCSD Science Kit Rotation: Dual Language Schools**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quarter 1</th>
<th>Quarter 2</th>
<th>Quarter 3</th>
<th>Quarter 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td><em>Weather</em></td>
<td>Wood &amp; Paper</td>
<td><em>Wood &amp; Paper</em></td>
<td>Animals 2x2</td>
</tr>
<tr>
<td>1</td>
<td>Pebbles, Sand, &amp; Silt</td>
<td>Balance &amp; Motion</td>
<td>Needs of Living Org</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Air &amp; Weather</td>
<td>Sound</td>
<td>States of Matter</td>
<td>Insects</td>
</tr>
<tr>
<td>3</td>
<td><em>Earth, Moon, &amp; Sun</em></td>
<td>Matter &amp; Energy*</td>
<td><em>Human Body</em></td>
<td>Plant Growth &amp; Dev.</td>
</tr>
<tr>
<td>4</td>
<td>Landforms</td>
<td>Rocks &amp; Minerals</td>
<td>Magnetism &amp; Elect</td>
<td>Anim Behav &amp; Adapt</td>
</tr>
<tr>
<td>5</td>
<td>Motion &amp; Design</td>
<td><em>Weather Forecasting</em></td>
<td><em>Living Systems</em></td>
<td><em>Ecosystems</em></td>
</tr>
</tbody>
</table>

*Note.* * denotes misalignment with CHCCSD rotation

From the outset, a stated goal of this science kit work was to align the scope and sequence for elementary schools across the district. In addition, the Science Coordinator began planning a reduced dependency on ECA Science Kit Services for refurbishment, maintenance, and delivery. With these goals in mind, the Science Coordinator began drafting budget projections to present to the Assistant Superintendent for Instructional Services. Ultimately, a plan was adopted to achieve the following:

- purchase up front, additional materials to supplement current inventory, allowing the consistent delivery of like science kits across the district, and
- begin drafting district-created units to supplement and then replace science kits as standalone units over the next 4 years.

In April of 2016, the Science Coordinator was asked to submit a report to the Executive Director of Curriculum and Instruction. A similar report was generated by each member of the Instructional Services Division in which content coordinators were asked to summarize their current work and its alignment with the district’s Long Range Plan goals. This section identifies each goal, along with selections from the Science Coordinator’s responses detailing his role in supporting these district goals and initiatives.
**Goal 1: Instructional Excellence.** A hallmark of this goal is a consistent, standards-based curriculum that is shared across the district. Curriculum planning across K–12 science involved consistent articulation using a common model (UbD). The design, piloting, and implementation of teacher-created units was underway throughout curriculum writing workshops, and the science kit revision process was initiated.

**Goal 2: Closing Gaps.** In closing achievement gaps between student populations, a common curriculum with standards-based assessments is targeted in the pursuit of regularly collected data. The consistent review of the data yielded from these assessments will not only assist teachers in planning student-specific supports, but allow the district to review and modify curriculum on a consistent basis. Data produced by shared science assessments helped to assess what instructional practices were working across the district.

**Goal 3: Culture.** The district’s Long Range Plan promotes a community-wide culture that encourages collaboration, innovation, and “personal growth in a trusting partnership within the community” (CHCCSs, 2015b, para. 1). The Science Coordinator cited anecdotal feedback in which teachers and staff expressed an appreciation for the curriculum planning work currently being done. This work had not been conducted in the previous 4 years, and many teachers appreciated the opportunity to collaborate, receive dedicated planning time, and develop common units and assessments. Appreciation was also expressed on behalf of building administrators. Various principals met with the Science Coordinator over the 2015–2016 school year, and one administrator specifically highlighted the efforts underway to positively connect central office initiatives to schools and professional learnings communities.

**Goal 4: Professional Development.** The school district unveiled Project Advance in the 2015–2016 school year as a professional development model designed to reward teacher growth
in a number of focus areas. One such area for professional learning was specifically titled “Understanding by Design” and maintained a focus on curriculum planning. The Science Coordinator expressed an interest in streamlining the unit development process (to include teacher training in unit design) with Project Advance and school and teacher professional development goals.

**Goal 5: Accountability.** Here again, the district’s focus on accountability measures were supported by the common science assessments under development across the district. These short cycle assessments were referenced as opportunities to measure student growth and assess the success of instructional strategies.

*Institute for Learning and Principles of Learning*

During the 2015–2016 school year, the CHCCSD continued its fifth year in partnership with the Institute for Learning (IFL). This network of scholar practitioners and consultants worked with the district to coach its nine Principles of Learning. According to the IFL, these research-based features are present in successful classrooms and schools (IFL, n.d.). A brief description of each Principle of Learning as they apply to curriculum development (where applicable) is provided below.

- **Organizing for effort:** Founded in the belief in a growth-based mindset, organizing for effort supports a rigorous curriculum that is matched to standards. Curriculum and instruction support sustained and directed effort on behalf of the students to yield high achievement through sustained work.

- **Accountable talk:** For classroom talk to promote learning, curriculum and instruction must be designed with deliberate opportunities for students to
collaborate with others. In doing so, they engage evidence, utilize sound reasoning, and respond to peers in a manner appropriate to a discipline.

- Clear expectations: Students achieve at high levels when curricula maintain descriptive criteria and models that are publicly displayed and shared with exemplars of mastery within the standards.

- Learning as apprenticeship: Curriculum is designed to allow learners to acquire complex, multidisciplinary content and skills through apprenticeship. Utilizing mentorship and coaching, complex critical-thinking skills are modeled and analyzed through extended projects, many of which are hands-on and problem-based.

- Socializing intelligence: Curriculum design incorporates habits of mind that allow students to engage content through newly acquired knowledge. Teaching practices should routinely communicate high expectations and a social obligation to make sense of the world.

- Fair and credible evaluations: Assessments should be fair, matched to standards, and clearly communicated to students, families, and community members. Students should regularly be able to see the results of their learning efforts.

- Self-management of learning: Like the fair evaluations referenced previously, students should also be allowed the opportunity to self-assess their progress and become increasingly responsible for their thinking and learning. Curriculum should teach standards while instruction incorporates these metacognitive skills.
Recognition of accomplishment: Regular progress and the recognition of accomplishments, though not directly related to curriculum design, is evidenced within effort-based schools and classrooms.

The district continued to use the nine Principles of Learning as a “common language to describe instructional expectations” within curriculum design (CHCCSs, 2016b, para. 2). The district’s contract with the IFL also included the purchase of exemplar, predesigned units in Grades K–12 in ELA and math. Middle and high school IFL units were purchased in 2015–2016 to be implemented in February of 2016. Although these units were not retroactively formatted to fit the district’s UbD templates, they were implemented to “serve as the first step to common curriculum and common assessments across schools” (CHCCSs, 2016b, para. 6).

Understanding by Design

In June of 2015, the district piloted UbD 101 as a part of its newly designed professional development model. This online course targeted classroom teachers and was the tool by which the district provided training on the UbD framework. Support sessions were offered throughout the district. Content coordinators continued to lead Instructional Planning Teams in the development of units within the UbD framework as part of their curriculum design process. Teachers and members of each Instructional Planning Team followed a common unit-design rubric, and these units were then shared with and vetted by the team.

This common unit planning model was implemented to yield a common scope and sequence across the district. As units were rolled out in a common sequence (Grades K–12 ELA and various grade levels/subject in Grades 6–12), Instructional Planning Teams were charged with identifying strengths and weaknesses of each unit. Notably, the district enlisted the assistance of a dual-language consultant to guide district administration in the development of an
action plan for designing curriculum at the district’s two dual-language elementary schools. This work incorporated a biliteracy framework as one additional step in lesson design (not unit design) in the dual-language curricula.

**Learning-Focused Planning**

In the fall of 2014, the CHCCSD began implementing the learning-focused instructional framework through a partnership with Dr. Max Thompson’s learning-focused organization. As a common lesson-planning template to be shared across schools, this level of instructional design allowed trained administrators to begin monitoring grade-level implementation of curriculum, units, and lessons arcs beginning in 2015. Building principals were trained to support implementation and ensure understanding of common curricular practices across the district. As a part of the district’s implementation plan, a series of rubrics, data metrics, and timelines were developed.

In the spring of 2015, principals developed an implementation timeline for their specific schools. Implementation plans included specific items for administrators to observe using a common rubric. Prior to the start of the 2015–2016 school year, principals revisited these plans and determined specific grade levels and/or content areas to target for observation. After choosing specific curriculum components to observe, collected data were reviewed at biweekly curriculum meetings at both the school and district levels. The quality of lesson design and unit implementation were to be assessed by principals using the previously designed rubrics. For individual teachers, principals were then tasked to host one-on-one conversations in the lead up to having these components included in the teacher evaluation process by January of 2016.
Vertical Alignment

In addition to a grade-level focus in curriculum design, the Instructional Planning Team and elementary school staff looked closely at content area strands as they pertained to K–12 science standards. Elementary Math/Science Specialists had the opportunity to review the middle school scope and sequence early in the science kit revision process. This allowed them to closely analyze sixth-grade content and establish key content to teach in fifth-grade units of study. The Math/Science Specialists also had one opportunity to meet with the middle school Instructional Planning Team, tour middle school science classrooms, and collaborate with these vertical colleagues to exchange ideas and resources. The final draft of the science kit rotation and elementary science scope and sequence was also shared with middle school science teachers, allowing them to effectively reference prior content knowledge in their own unit planning.

Summary

This chapter provided the results of data organization and analysis as detailed in Chapter 3. A systems theory framework was used to connect systems and the nature of their interactions within the CHCCSD as it redesigned an elementary science curriculum. The data suggested that district spending on one curricular tool varied across 11 schools within one school district. Results indicate a varied implementation of science kits across the district when compared to student enrollment numbers. Finally, this chapter considered the guiding principles and key themes driving curriculum development, which included components of the district’s Long Range Plan, longitudinal objectives of the Department of Curriculum and Instruction, and feedback solicited from both staff and administrators at the building level. A variety of historical factors and guiding principles influenced the CHCCSD’s development of elementary science
As previously highlighted, there is often a research void regarding the fiscal implications of curriculum. The approximately $200,000 spent annually by the CHCCSD on science kits was rarely reviewed for effectiveness prior to 2015. In addition, these funds were often delivered inequitably across the 11 elementary schools when examined on a per pupil basis. Though the benefits of science kit usage were evident in key stakeholder groups (for example, within the data collected by the science kit survey), the district further pursued specific criteria to measure the effectiveness of their delivery. Chapter 5 of the dissertation will seek to answer the research questions with the findings described in Chapter 4. In discussing the study’s results, Chapter 5 will propose implications and recommendations for practitioners and suggest opportunities for future research.
CHAPTER 5: DISCUSSION AND CONCLUSIONS

Chapter 5 of this dissertation seeks to answer research questions by using the findings found within Chapter 4. The discussion also includes a comparison of the findings with the literature review. Where applicable, recommendations are made to practitioners and for future research.

The first section of this chapter answers the study’s research questions. Each question and subquestion are answered with brief synopses from Chapter 4. Conclusions for each research question are presented accordingly. The second and third sections of the chapter outline policy and practice recommendations, respectively. The chapter concludes with future research suggestions and summary conclusions.

Data analysis of documents, financial data, archival records, and new narratives provide operational measures to provide focus to my findings (see Figure 3.1, Chapter 3). It should be noted that all reported financial amounts have been inflation adjusted using the conversion factors detailed in Chapter 3. A systems theory conceptual framework is adapted and used to guide the discussions and conclusions. This approach analyzes sociocultural systems and their impact on curriculum. These include funding, district guiding principles, and historical factors as they relate to curriculum development and implementation. Table 5.1 details the analytic methods used to arrive at related findings for each research question.
Table 5.1

Overview of Methods and Findings

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Analytic Methods</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>What revenue sources fund the design and implementation of elementary science curriculum?</td>
<td>Document analysis</td>
<td>Local Funds</td>
</tr>
<tr>
<td></td>
<td>Descriptive trends in revenue over time</td>
<td>Defined by budget codes as system-wide support services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Establishes connection between funding sources and curriculum</td>
</tr>
<tr>
<td>How are funds expended in the design and implementation of elementary science curriculum?</td>
<td>Document analysis</td>
<td>Approximately $207,000 spent annually on elementary science kits</td>
</tr>
<tr>
<td></td>
<td>Descriptive trends in expenditures over time</td>
<td>Accounts for roughly 7% of the Instructional Services budget</td>
</tr>
<tr>
<td>To what extent do school districts invest in these efforts vis-à-vis science kits and how are these expenditures allocated across schools within a district?</td>
<td>Document analysis</td>
<td>Average of $37 spent per student for science kit implementation</td>
</tr>
<tr>
<td></td>
<td>Memo writing</td>
<td>Additional $24,086 allocated for additional science kit materials in 2016-2017 school year</td>
</tr>
<tr>
<td></td>
<td>Descriptive trends in science kit implementation over time</td>
<td>Long term plan established to reduce district reliance on science kit refurbishment</td>
</tr>
<tr>
<td>What guiding principles or district goals influence the design of curriculum?</td>
<td>Document analysis</td>
<td>Teacher-designed, common curricula across all schools</td>
</tr>
<tr>
<td></td>
<td>Memo writing</td>
<td>Unspoken preference for the “status quo”</td>
</tr>
<tr>
<td></td>
<td>Observed patterns in principles and district goals</td>
<td></td>
</tr>
<tr>
<td>What longitudinal data support the implementation of curriculum?</td>
<td>Document analysis</td>
<td>Regularly-scheduled follow up meetings with math/science specialists</td>
</tr>
<tr>
<td></td>
<td>Memo writing</td>
<td>Teacher survey of science kit use</td>
</tr>
<tr>
<td></td>
<td>Descriptive trends in the assessment of curriculum implementation</td>
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</tbody>
</table>

Research Questions

The case study’s purpose is to explore the funding of curriculum development and implementation in the CHCCSD. Specifically, funding, along with historical trends in curriculum planning, is analyzed through the implementation of elementary science kits. A new elementary science curriculum accompanied a revised science kit rotation model to establish a common scope and sequence across 11 elementary schools. Previous science kit rotations used an
alternating scope and sequence to implement these hands-on activities with the goal of being more resource efficient; however, the science kit revision process was modified as part of a district-wide initiative to develop common curricula across all buildings. The following research questions were designed to identify revenue sources and expenditures in the design and implementation of curriculum and analyze guiding principles or district goals that influence this process.

**What Revenue Sources Fund the Design and Implementation of Elementary Science Curriculum?**

When referencing the findings of Chapter 4, funding for elementary science kits and the planning for their usage is identified as a locally funded initiative. As defined by the North Carolina Department of Public Instruction, these purchased services are allocated for system-wide support services related to the general admission of a school district. This local current expense fund is appropriated for the operating expense of a school system separately from the appropriations included in the State Public School Fund and Federal Grant Fund. Revenue sources include supplemental taxes and county appropriations. Science kits and their implementation timeline played a critical role in defining curriculum for this study.

Funds for elementary science kits are located within the Instructional Services budget. As overseen by the Assistant Superintendent for Instructional Services, this budget averages $1.5 million annually. Budget codes define this fund allocation as system-wide support services. Approximately $200,000 (adjusted for inflation) was spent in 2014–2015 on science kits. Likewise, funding for the district’s curriculum planning work originates from the very same revenue sources. This includes professional development for various support personnel. Local
funds support school-based support and instructional services. The works of Instructional Planning Teams and Math/Science Specialists are delineated as staff development activities.

This first research question highlights the relationship between funding sources and curriculum. This relationship will be further unpacked in subsequent sections. The quantitative data establish the basis for answering additional research questions. Local revenue sources such as supplemental taxes highlight inter-district and state-to-state funding disparities that impact access to curricular and instructional materials. Financial factors beyond per pupil expenditures impact student outcomes, which was not the focus of this study. However, school district culture and historical trends that impact student outcomes will be further analyzed in subsequent sections.

**How Are Funds Expended in the Design and Implementation of Elementary Science Curriculum?**

The CHCCSD employed nine subject coordinators in the 2015–2016 school year. These administrators are tasked with facilitating the design and implementation of district-wide curriculum. The Instructional Services Division to which they belong is allocated approximately $4,000,000 annually for operations. When teacher salaries and benefits are included, the district averaged approximately $107,000,000 annually within the broader category of Instructional Services. Instructional Services accounted for 72.8% of the district’s total operating budget in the 2014–2015 school year.

The Science Coordinator’s work with the CHCCSD’s Instructional Planning Team began in the 2014–2015 school year at an annual salary of $67,000. Each of the 11 elementary schools was also allocated a 0.5 Math/Science Specialist (approximately $26,000 per year). Additionally, $3,256 was spent on instructional planning work, which included science kit revisions. The
majority of this expense covered substitute teacher costs for team members as they participated
during normal work hours in four full-day sessions. Local funds were allocated for this
curriculum design work.

Implementing the district’s science curriculum involved the use of science kits at the
elementary level. District-wide expenditures on these kits ranged from $200,830 to $215,836
annually between 2012 and 2017 (adjusted for inflation). These costs accounted for 6% to 8.3%
of the total Instructional Support Services budget. This funding comes directly from the Local
Current Expense Fund. The district’s investment in science kits is further discussed in the
following section.

The relatively small amount of funds spent on the curriculum design process presents
challenges in tracking the practical impacts of the district’s work. Teachers serving on the
Instructional Planning Team had different styles in drafting curricula, as researched by Miller
(2011). Only minor changes to middle and high school science curricula, as well as the
elementary science kit rotation, were produced over the course of 2 years. Changes in curriculum
require time and a potential shift in culture (Jorgenson, 2006).

Although the most significant cost of elementary science curriculum implementation can
be attributed to personnel (teaching salaries and benefits), variability in teacher efficacy,
instructional practices, and other factors make it difficult to establish a correlation between
human resource costs and curriculum delivery. For this and other reasons, the purchase and use
of science kits are isolated as curriculum and instructional resources.

The interaction between the Science Coordinator, Math/Science Specialists, teachers, and
administrators contributed to the overall revision of the science kit model. These interactions are
directly impacted by historical factors within the district. These systems (further explored in later
research questions) maintain long-term financial implications for the district and at various times display both cohesion and conflict with the district’s guiding principles.

**To What Extent Do School Districts Invest in These Efforts Vis-à-Vis Science Kits?**

When adjusted for inflation, the CHCCSD saw an increase in total operating expenses, per pupil expenditures, and allocations for instructional support services between the years 2012 and 2017. As seen in Table 5.2, money invested into the implementation of science kits did not always mirror these increases. On average, the science kit allocation accounted for approximately 7% of the district’s instructional support services budget. When analyzed on a per-elementary student basis, science kits cost the district an average of $37 per elementary student each year between 2012 and 2017. In other words, science kit expenditures were less than 0.5% of per pupil costs at the elementary level. Across the state of North Carolina, approximately $440 were spent per pupil for total student support services.

**Table 5.2**

**Select Finance (Data CHCCSD 2012–2017)**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Total operating expenses</td>
<td>$126,514,901</td>
<td>$126,199,998</td>
<td>$128,312,703</td>
<td>$128,991,814</td>
<td>$131,686,132</td>
</tr>
<tr>
<td>Per pupil expenditures</td>
<td>$10,445</td>
<td>$10,385</td>
<td>$10,610</td>
<td>$10,669</td>
<td>$10,878</td>
</tr>
<tr>
<td>Instructional support services (total)</td>
<td>$2,583,078</td>
<td>$2,539,319</td>
<td>$2,980,688</td>
<td>$3,236,653</td>
<td>$3,147,258</td>
</tr>
<tr>
<td>Science kit services (actual)</td>
<td>$200,830</td>
<td>$210,516</td>
<td>$193,530</td>
<td>$194,264</td>
<td>$215,836</td>
</tr>
<tr>
<td>Science kit cost per elementary student (average)</td>
<td>$37</td>
<td>$38</td>
<td>$35</td>
<td>$35</td>
<td>$39</td>
</tr>
</tbody>
</table>

*Note. Adjusted for inflation.*

In addition to the annual funds spent on science kits, the district allocated an additional $24,086 for the 2016–2017 school year for the purchase of additional science kit materials. This allowed the district to move away from a shared resource model in which one kit would rotate
between schools. In this previous model, for example, the second-grade insects kit may start at one building for the first quarter of the year before the kit is then refurbished and shipped to three other schools for the remaining three quarters. The purchase of additional materials allowed the same insect kit/unit to be taught at the same time across 11 different buildings. This up-front investment highlighted the district’s commitment to a common, district-wide curriculum. The district also began allocating resources for teacher collaboration in the development of standalone units to both supplement science kits and, ultimately, replace obsolete and irrelevant kits/units.

Until district-created units were available, the plan developed in 2016 would continue to use science kits for an additional 3 years. As shared within the science kit survey, teachers appreciated the ease of use inherent within prepackaged science kits. Many of these teachers were tasked with teaching multiple subject areas and anecdotally, some did not consider science to be their strongest content area. The use of science kits within the CHCCSD provided teachers with several benefits:

- A longitudinal increase in a teacher’s science knowledge
- Increased confidence
- Increased use of inquiry-based instruction

The district’s short-term, continued use of science kits also exemplifies the organization’s acknowledgment of a historical context therein. As communicated by the Math/Science Specialists, there was an initial reluctance to move away from science kits given the teachers’ familiarity with their contents and use. This impacted the historical science curriculum within the district at the elementary level. The time needed to redesign science kit rotations and the associated costs presented as opposing systems to deep curricular alignment.
How Are These Expenditures Allocated Across Schools Within the District?

A final science kit revision was proposed for implementation in 2017. Rather than equal distribution of science kits to each of 11 elementary schools or a proportionate number relative to the number of students in each building, kits were distributed based on the number of science classes being taught. Each elementary school employed one of two science kit delivery models. In buildings where each grade-level teacher taught and received a science kit, science kit costs were higher (approximately $21,000 in certain buildings). In schools that departmentalized (one science teacher teaching one grade level and using one kit), costs were lower (approximately $16,000). Table 5.3 and Figure 5.1 detail the difference in expenditures across the CHCCSD in 2016–2017.

Table 5.3

2016–2017 Science Kit Distribution Across 11 Elementary Schools

<table>
<thead>
<tr>
<th>School</th>
<th>Number of kits received</th>
<th>Dollars spent for science kits</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrboro Elementary</td>
<td>24</td>
<td>$20,314</td>
<td>738</td>
</tr>
<tr>
<td>Ephesus Elementary</td>
<td>19</td>
<td>$16,082</td>
<td>396</td>
</tr>
<tr>
<td>Estes Hills Elementary</td>
<td>23</td>
<td>$19,468</td>
<td>765</td>
</tr>
<tr>
<td>Glenwood Elementary</td>
<td>21</td>
<td>$17,775</td>
<td>483</td>
</tr>
<tr>
<td>FPG Elementary</td>
<td>23</td>
<td>$19,468</td>
<td>578</td>
</tr>
<tr>
<td>McDougle Elementary</td>
<td>22</td>
<td>$18,621</td>
<td>511</td>
</tr>
<tr>
<td>Morris Grove Elementary</td>
<td>25</td>
<td>$21,160</td>
<td>545</td>
</tr>
<tr>
<td>Northside Elementary</td>
<td>25</td>
<td>$21,160</td>
<td>499</td>
</tr>
<tr>
<td>Rashkis Elementary</td>
<td>25</td>
<td>$21,160</td>
<td>502</td>
</tr>
<tr>
<td>Scroggs Elementary</td>
<td>23</td>
<td>$19,468</td>
<td>508</td>
</tr>
<tr>
<td>Seawell Elementary</td>
<td>25</td>
<td>$21,160</td>
<td>549</td>
</tr>
</tbody>
</table>

Note. Adjusted for inflation.
This difference in delivery model exemplified key curriculum and instruction differences across buildings. The implications were influenced by and likewise impacted cross-curricular factors: which teachers taught which subject areas. This variability in curriculum delivery makes it difficult to assess efficacy (Brighouse, 2004). Macedo’s (2013) claim that exploring educational adequacy must consider policy and educational theory will be further examined later in this chapter. However, the surface-level difference in educational equity, as represented by the 50% per pupil cost difference in science kit expenditures from school to school, must be considered through the lens of differing instructional models.
Here again, the desire to maintain the status quo impacted proposals to change the science kit delivery model. The following section describes teacher and staff feedback in addition to district guiding principles and goals that collectively influenced the design of elementary science curriculum.

What Guiding Principles or District Goals Influence the Design of Curriculum?

In 2015, the Science Coordinator for the CHCCSD began hosting regular meetings with Instructional Planning Teams and elementary Math/Science Specialists. This team began a thorough review of the science kit rotation schedule. Meetings with the Executive Director of Curriculum and Instruction, as well as the Assistant Superintendent, steered this work toward a common, vertically aligned curriculum and an accompanying redesign of the science kit model. This section highlights several factors uncovered in the analysis of historical documents and artifacts.

District Long Range Plan and Guiding Principles. The CHCCSD highlighted three themes in their 2012 Long Range Plan: the need to eliminate the district’s achievement gap, the need for quality professional development, and the unifying belief in a growth mindset. The district promoted these themes through work in coaching growth mindset beliefs, equity and engagement, and consistent professional learning opportunities. Collaboration and accountability were layered into the work of developing curriculum and instructional practices.

Teacher-Based Curriculum Design. Enlisting the work and expertise of teachers in this process was purposeful to promote ownership and buy-in. Stakeholder groups such as the Math/Science Specialists were heavily relied upon for feedback regarding science kits and their historical use within the district. The teacher survey was able to collect science kit feedback from every grade level at every elementary school. The building-level input of teachers and staff
allowed for the planning of science curriculum to also interface with the curricula in other disciplines. Involving the teaching staff in redesigning science kit use promotes the research of Rennie et al. (2010), with related goals to (a) increase teachers’ core science knowledge, (b) increase teacher confidence, and (c) increase and promote the use of inquiry-based instruction

**Understanding by Design.** The district continued its curriculum design work, including elementary science curriculum, utilizing a backward design framework. Teachers, Math/Science Specialists, and the Science Coordinator were tasked with using state learning standards as the foundation for curriculum planning. Student learning targets were developed, and the integration of science kits was thus viewed as a supplemental resource. Historically, the science kits dictated instruction. As a result of curriculum planning, science kit materials would now be utilized to highlight content within a separately designed unit.

**Common Curricula.** Through the curriculum design process, establishing a common curriculum across 11 elementary schools remained a key focus of curriculum planning. Teachers across different buildings would teach the same content in addition to following the same sequence of units of instruction. This common scope and sequence would ensure similar educational experiences across the district. In addition, standards-based postassessments would allow broader, district-level conversations regarding student performance, and thus refinement of these curricula. Finalizing curricula across multiple disciplines also promoted the integration of cross-curricular units of study. For example, students in social studies class could read nonfiction texts about the Dust Bowl while concurrently studying erosion in science class. They could then author argumentative essays in ELA class regarding the pros and cons of agricultural practices in their state.
Preference for the Status Quo. Several meetings with administrators within the dual-language program (maintained at two of the 11 elementary schools) influenced the final outcome of the elementary science kit timeline. This regression to prior models indicated adherence to previously established practices that were at times in conflict with what was being proposed. This ultimately led to two schools being out of alignment with the other nine elementary buildings. Other examples include the short-term, continued commitment to science kits and the accompanying contract with ECA Science Kit Services.

These factors contributed to the systems at play within the curriculum design process. Teachers overwhelmingly communicated an appreciation for the science kits and the hands-on experiences that the kits provided in an easy-to-use system. Some challenges were discovered, such as unaddressed standards, the annual cost, and the previous lack of common alignment. The totality of these factors influenced the district’s move toward a common science curriculum. This goal dictated the revision of the science kit timeline along with the spending of additional funds to make the timeline possible.

However, the goal of a shared, district-wide science kit timeline across 11 schools was ultimately undermined by the rotations currently in place at two elementary schools. These two buildings were allowed to maintain separate sequences for three grade levels to maintain cross-curricular alignment with their dual-language units of study. These units had been in place for several years prior to the development of a common science curriculum. The advocacy of building administrators and Math/Science Specialists at these two schools convinced the Assistant Superintendent, Science Coordinator, and other stakeholders to allow this discrepancy. A plan was developed for collaboration between the two schools as a smaller cohort within the three grade bands.
What Longitudinal Data Support the Implementation of Curriculum?

A schedule of regular meetings with Math/Science Specialists laid the foundation for the soliciting and receiving of regular feedback throughout the design and implementation of science curriculum. Surveys were distributed regarding science kits, proposals were presented, and follow-up surveys (both formal and informal) were documented. This feedback allowed teachers, math/science specialists, and other stakeholders to inform the work of revising the science kit model for the CHCCSD.

Analysis of survey data and stakeholder correspondence found variability in the frequency of science kit usage. ECA Science Kit Services reported in rare instances receiving back unopened kits from elementary buildings. Math/Science Specialists and school administrators also reported variability in the fidelity of implementation. Building schedules also varied in the amount of science instruction provided. Sample schedules included such examples as science units taught once per quarter, science instruction delivered every other day (as opposed to math and ELA being taught daily), science taught every other week, or science being taught every day.

Additionally, many teachers and Math/Science Specialists documented the supplementing of science kits with additional resources, materials, and content. This included field trips in some buildings, teacher-created materials, and additional, third-party resources such as textbooks, online resources, or guest speakers. There was neither a cohesive database that housed these resources nor a consistent means to evaluate relevance or effectiveness. To address this variability, the Science Coordinator introduced the district-developed unit and lesson-planning template in designing common curriculum.
The unit-design template incorporates the use of formal and informal assessment techniques to assess student understanding. Data acquired from these assessments were intended to be used as teachers continued to refine curriculum and instructional practices. The Science Coordinator also pursued a feedback loop for science kit delivery in the form of postunit teacher surveys. The focus of both student assessments and teacher surveys was on the evaluation of science curriculum effectiveness in meeting learning targets and teaching science content standards.

Feedback loops (from staff, student assessment data, and continual curriculum revisions) are noted as the final sociocultural component within a series of systems that influence the development and implementation of science curricula. Collaboration and feedback influenced the final elementary science kit rotation schedule in working towards the goal of common, district-wide curricula. A district-created curriculum would then reduce and eliminate dependence on ECA Science Kit Services and the accompanying costs associated with this annual contract.

Policy and Practice Considerations

The CHCCSD redesigned its elementary science curriculum for the 2016–2017 school year. This involved the redeployment of elementary science kits, which involved an annual investment of more than $200,000. This study reviewed factors, including funding and investments, influencing the curriculum development process. This section details policy and practice considerations for schools and school districts when planning for major curriculum initiatives and/or changes. Areas addressed include curriculum articulation, teacher professional development, and the allocation of resources as they relate to science curriculum development.
Strong, Backward-Designed Science Curriculum

School districts must constantly adapt to changes in national and state education standards. They must also adapt to systems of accountability in an era of high-stakes testing (Au, 2011). A well-designed curriculum provides schools and teachers with a plan and structure for delivering high-quality instruction. Working backward from standards as learning targets, an effective curriculum identifies student learning objectives as well as the ways in which students will demonstrate mastery of these objectives. The UbD framework was used in the CHCCSD as a curriculum and unit-planning template to produce a common scope and sequence across the district.

Utilizing a consistent curriculum planning model allowed for consistent collaboration across 20 schools within the CHCCSD. When teachers and staff from 11 elementary schools began planning a common science curriculum, they were well-versed in UbD, having previously designed ELA and math curricular units at the elementary level. The benefit of having a common tool for curriculum design eliminates the variability in teacher preference/style in drafting curriculum (Miller, 2011). Additionally, the use of a common unit-planning template gives rise to common lesson-planning templates. Consistency eases the further collaboration of teachers in refining instructional practices to better serve students.

Inquiry-based science instruction should incorporate scientific practices that capture the ways of doing science and the practices of scientific exploration (Walker & Warfa, 2017). Students should be afforded the opportunity to pose questions, generate and test hypotheses, and analyze and interpret data. The social nature of the field should also be incorporated. Students should engage in arguments while citing evidence, and collaborate, lead, and participate in group activities. These transferable skills should be layered within broader units of study.
Teaching pedagogically sound science instruction requires a well-crafted curriculum that has the following attributes:

- **Student-centered:** Science curricula should take into consideration student understanding and background. Instruction should integrate students’ personal views of the world around them.

- **Future-ready:** A secondary focus on college and career readiness means that students should acquire the content and skills needed to be successful in their postsecondary endeavors.

- **Flexible:** College and career readiness cannot maintain a one-size-fits-all approach. Curricula should be adaptable to meet the unique needs of individual students.

- **Focused and coherent:** Science curricula should maintain fidelity to the scientific concepts and inquiry abilities that allow for deep understanding. Spiraling science curricula across multiple grade levels allows for vertical alignment and deeper levels of sophistication as students progress through their studies in science.

- **Rigorous:** Instructional practices and materials must foster a learning sequence that provides adequate time for students to build conceptual understanding and connections between topics.

If a teacher-developed curriculum cannot initially satisfy the above criteria, science kits can be utilized to provide focus, coherence, and hands-on opportunities for inquiry-based exploration. Science kits have long been recognized as a close approximation of age-appropriate science curricula because they present clear content with clear learning targets (Steiner et al., 2017). Science kits offer teacher- and student-friendly materials that support laboratory exercises.
within traditional science content. Teachers within the CHCCSD expressed the following benefits of science kit usage: (a) increase in teacher core content knowledge/curriculum, (b) increase in teacher confidence in science instruction, and (c) increase in the use of hands-on, inquiry-based learning.

However, science kits provide more success when paired with appropriate teacher professional development regarding their effective use (Rennie et al., 2010). In addition, measures to evaluate science kit effectiveness should also be considered (Blanchard et al., 2013). Subsequent sections include recommendations to assess science kit implementation.

**Coherent Teacher Professional Development**

The redesign of the CHCCSD’s elementary science curriculum benefited from professional learning opportunities provided to key staff members. When rethinking elementary science curriculum, the following professional development topics should be considered. The ordering is not prioritized. Rather, school districts should consider effective ways to pursue these topics concurrently across their teaching staff.

**Science Content.** Steiner et al. (2017) highlighted teacher education programs, professional development, and instructional resources that heavily favor math and literacy over science. Teachers should receive regular professional learning regarding science, inquiry-based learning, and where applicable, the use of science kits. Science methods courses should expand inquiry-based teaching strategies to coach teachers in flexible approaches to incorporate variations within hands-on learning. In this way, teachers can adapt science kits to meet their curricular needs and, more importantly, the individualized learning needs of their students.

As science content and pedagogy relate to curriculum writing, teachers should also be exposed to the spiraling nature of science content throughout a K–12 continuum. The strands of
life, physical, and earth sciences build upon themselves in each grade level. Even though elementary science standards cover a broad range of topics at each grade level, understanding this verticality within fundamental concepts will allow teachers to communicate the importance of key topics to students. Teachers should also gain an understanding of what was taught in prior grade levels to effectively leverage students’ prior content knowledge in planning their curriculum and instruction. Knowledge of future grade levels and how science strands fall within them will also help teachers develop learning targets that set students up for future success.

**Curriculum Writing.** Teachers should receive training regarding the curriculum design process. The importance of standards-based learning should guide curriculum writing. The inquiry-based goals of an effective science curriculum should be taken into consideration. Teachers should ensure that their written curriculum engages students in the science practices. The UbD model provides teachers with a flexible model to adapt curriculum and materials if and when science standards change. However, they can likewise maintain fidelity to their essential practices.

Additionally, as teachers engage the UbD framework, they should focus on the model’s key tenets, as described by Wiggins and McTighe (2005):

- Curriculum should be focused on a student’s deep understanding and their transfer of knowledge and skills.
- Student understanding is demonstrated when they can explain, interpret, apply, and self-assess content knowledge.
- Curriculum is best developed when planned backward from long-term results or standards. A textbook or science kit (or science kit rotation) should not dictate a curriculum.
• Teachers use curriculum to ensure that learning is happening by coaching for understanding and providing opportunities for students to engage the content independently and collaboratively.

• A process of continual improvement means that curriculum should be regularly reviewed to enhance quality and effectiveness. This should be done through professional discussions among teachers delivering the curriculum.

Assessment Use. In order to evaluate the effectiveness of a curriculum, UbD requires the use of regular checks for understanding. Stiggins (2002) further argued that teachers should not only check for understanding, but maintain the goal of advancing student learning. Teachers should move beyond the formative assessment process as an assessment of learning. Though this is important, assessment for learning utilizes activities and assignments as a means to help students learn more and develop metacognitive ability (i.e., learn how to learn).

Teachers should be trained to identify the qualities of effective assessment use. They should be able to develop high-quality assessments that reflect a clearly identified learning target. These assessments should include a variety of measures of student achievement. In addition, teachers should be aware of the external factors that influence student performance. Assessments should provide meaningful data to teachers. This data should be analyzed uniformly across a district to inform the regular improvement of classroom instruction.

Differentiated Learning. Teachers should avoid a one-size-fits-all approach to the use of science kits. The effective use of assessment data should allow teachers to refine their instruction, remediation, and acceleration of the different students in their classroom. When a backward-designed curriculum is able to identify learning targets, and well-designed assessments
can identify student proficiency, teachers can effectively differentiate their teaching practice to meet a variety of student mastery levels.

Providing teachers with professional learning in science content and the use of science kits as inquiry-based resources can enhance their practical means to provide this student-centered support. Curriculum developers should include with each science kit or unit differing levels of scaffolding. As a resource, the science kits can offer to teachers different variations of the same lesson within their use of an inquiry continuum.

**Flexible Leadership in Curriculum Development**

The final policy and practice recommendation suggests maintaining leadership of the curriculum development process in a manner that is flexible and responsive to the unique needs of a district and its schools. As stated previously, effective curriculum and instruction must rely on outcome-based planning, research-based practice, differentiated instruction, and engaging students in a manner that develops automaticity with content knowledge (Van Heukelum, 2014). Establishing a learning culture requires significant motivation from district and building-level leaders. On an intellectual level, teachers must be encouraged to innovate and create curriculum. Articulating a vision that is inspiring to teachers models a modern curriculum, which accommodates a shift to the 21st-century skills that industry and higher education desire.

The first leadership recommendation is for district and building leaders to articulate and maintain clear curriculum development goals for teachers and staff. This shared vision should be accompanied by shared goals, such as those outlined by the CHCCSD’s Long Range Plan. These goals provide key personnel with ways to assess group efforts. Sharing goals also establishes a shared responsibility for success. When utilizing tools such as science kits, leaders should establish explicit guidelines for their use while also allowing for flexible choices in how they are
delivered. Teacher tools should allow for variations in how inquiry-based lessons are utilized to meet student needs.

Secondly, school and school-district leaders must develop an awareness of institutional culture. The intangibles of schools (teacher dispositions, teacher comfort level, etc.) further complicate the systems at play in developing and implementing curriculum. Wagner (2001) described teachers as risk averse by nature, often seeking the path of least resistance in curriculum mapping. However, a shared vision for success can incorporate reasonable risk-taking when collegiality promotes action research, collaboration, and working together towards common goals. Addressing the broader systems at play in the time-intensive process of curriculum design requires a supportive culture (Jorgenson, 2006).

This culture must also be accompanied by a reasonable skepticism of the status quo. Striving for continuous improvement, systems of accountability should provide a feedback loop that improves curriculum and implementation regardless of how well students are performing. Just as content-based assessments linked to learning targets inform teaching practices, measurable outcomes relative to district goals should be accompanied by criteria for success. Staff and administrators should be aware of a feedback process and ways for feedback to inform decision-making.

Lastly, school leaders and the decisions they make should be leaders in educational equity. Schools must meet the diverse needs of a diverse student population. Content-specific resources that incorporate the complexities of student backgrounds are increasingly common in K–12 education. This broadening of topics and resources improves the breadth and depth of content, making it more “comprehensive, updated, and relevant (de la Garza, 2021, p. 123). Districts should consider multicultural resources when allocating resources. These materials
should encompass a range of cultural backgrounds and remain mindful of the student demographics within a district. However, this study did not produce sufficient data regarding the unequal distribution of science kits and funding and any subsequent impacts on student learning outcomes. Thus, recommendations cannot be made regarding funding and the persistent achievement gap currently in place in districts across the country.

Further Research Considerations

As the current study was limited to analyzing one school system, there is room for additional research both within and beyond the state of North Carolina. At the time of this study, several other districts within central North Carolina and throughout the state were using science kits within their elementary science curriculum. Very little data were produced regarding efficacy or student learning outcomes, specifically in lower grade levels (kindergarten through third grade). One research possibility is to conduct inter-district studies regarding science kit use relative to student performance on a common assessment (such as the Grade 5 science End of Grade assessment). Spending models and how related systems impact funding and curriculum implementation could also be studied to analyze educational equity. Furthermore, the time spent on science instruction, which varies across different schools, could be analyzed for effectiveness. Finally, teacher dispositions within a broader school and/or district culture could be explored regarding curriculum development and implementation. These topics are further discussed below.

Curriculum Effectiveness

Both before and during the curriculum development process, teachers must assess what students know relative to content learning standards. A variety of summative and formative assessments can be done throughout a given unit or school year (Copp, 2016). An extension of
the current study could be the exploration of assessments and how elementary science teachers gauge student ideas. Further still, how teachers utilize the information gathered from these assessments to inform their instruction could also be studied. Teachers can utilize this information to modify curriculum materials to meet the needs of students within the classroom.

**Equitable Funding**

In researching student learning outcomes, one should also examine the sufficient use of educational resources to enable students to reach levels of proficiency. How resources such as science kits are distributed varied within one school district and is likely to show variability across districts. This study leads to additional questions regarding school funding models and funds spent on educational resources. Although many schools strive for a culturally responsive curriculum that responds to the uniqueness of each student (Allen & Hunsaker, 2016), systems, policies, and teacher dispositions often mean that funding inertia serves to maintain the status quo (Psacharopoulos, 2006). Student gains are often inequitable, and though research has been conducted into the effectiveness of teaching practices in closing achievement gaps (Thompson, 2015), further study into the funding of curriculum development is needed.

When considering the funding impacts on science curriculum and implementation, this study did not consider a variety of demographic data that have previously been researched as they relate to student achievement and the achievement gap between different student groups. These demographic factors include race, gender, and socioeconomic status. Others include school size, community type (rural, suburban, or urban), and levels of teacher education or number of years of teaching experience. The interrelatedness of these social factors within the systems governing science education should be further studied.
**Science Instruction: Time**

The time spent on science instruction is another variable overlooked by this study. As referenced in Chapter 4, different schools within the CHCCSD dedicated different amounts of time to science instruction (as a percentage of total class time). In a 2012 national survey cited by Banilower et al. (2013), elementary teachers reported teaching math every day of every week of a given school year. By contrast, only 20% reported teaching science all or most days every week of the school year. Table 5.4 displays the average number of minutes spent per day on instruction in various subject areas in different grade bands.

**Table 5.4**

*2012 Average Number of Minutes per Day Spent Teaching Different Subjects, by Grade Bands (Banilower et al., 2013)*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Grades K–3</th>
<th>Grade 4–6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading/language arts</td>
<td>89</td>
<td>83</td>
</tr>
<tr>
<td>Mathematics</td>
<td>54</td>
<td>61</td>
</tr>
<tr>
<td>Science</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Social studies</td>
<td>16</td>
<td>21</td>
</tr>
</tbody>
</table>

Differences in delivery models and contact time in each subject area should be explored. Utilizing a systems theory would allow researchers to analyze the factors within a district influencing the distribution of contact time for each of the various elementary subject areas. Longitudinal studies evaluating student science mastery in middle and high school could examine the foundational content being taught (or not taught) at the elementary level.
Teacher Mindset

This study noted the various interactions maintained by the Science Coordinator with Central Office Administrators, Building Principals, and Math/Science Specialists. However, the study did not review any detailed interactions with teaching staff. As teachers are the ones primarily responsible for the delivery of science instruction, further research should investigate teacher dispositions as they relate to curriculum. In addition to the implications that policies maintain on what and how to teach, teachers are directly impacted by a variety of factors that could be analyzed, including education levels, years of experience, confidence in teaching science, and feeling of preparedness to teach science (availability of resources, etc.).

Summary Conclusions

The redesign of the CHCCS elementary science curriculum required a revision to the district’s use of elementary science kits. Historical factors, funding sources, and guiding principles impacted the development of a new science kit rotation schedule. Feedback and accountability should be considered in future curriculum development. Administrators should provide professional learning for teachers in the areas of curriculum writing, assessment use, and differentiated learning in addition to ensuring that they maintain a strong understanding of science standards.

District spending on science kits was highly variable across 11 elementary schools. Guiding principles and key systems were documented within the interactions between administrators, teachers, and staff. These systems impacted curriculum development and carried with them long-term financial implications. The approximately $200,000 spent annually on science kits was rarely reviewed for effectiveness because the district maintained consistency.
year to year. Over time, these kits fell out of alignment with state standards, and teachers did not receive the professional learning needed to deliver the kits with fidelity.

As school districts continue to adapt to the changing landscape of education standards and school funding models, school administrators will need to be flexible in providing teacher and classroom support when developing and implementing curriculum. These curricula should be standards-based and accompanied by clear measures of success so that student mastery can be assessed and differentiation provided as appropriate. Leaders must ensure that school and district cultures are ripe for change by promoting shared goals and a vision for success.
APPENDIX A: TEMPLATE FOR DOCUMENTARY ANALYSIS

1. TYPE OF DOCUMENT (check one)
   ___ Policy Code  ___ Report  ___ Budget Document
   ___ Memorandum  ___ Correspondence  ___ Meeting Agenda/Minutes
   ___ Strategic Planning document  ___ Other: _______________________

2. PHYSICAL QUALITIES OF DOCUMENT (check one or more)
   ___ Logo, letterhead  ___ Notations  ___ Handwritten
   ___ Typed  ___ Signature(s)  ___ Seals
   ___ Dated  ___ Other: _______________________

3. DATE(S) OF DOCUMENT: ___________________________________________
   REFERENCE (for retrieval purposes): ________________________________

4. AUTHOR(S) OR CREATOR(S): _______________________________________
   POSITION/TITLE: _______________________________

5. FOR WHAT AUDIENCE WAS THE DOCUMENT CREATED?

6. ANALYSIS
   A. List three key ideas/themes/issues identified in the document
      i. 
      ii. 
      iii. 
   B. Why was this document written and what evidence is there for this conclusion?
   C. What questions are left unanswered by the document?
APPENDIX B: CONVERSION FACTORS USED TO ADJUST FOR INFLATION

When analyzing financial data, it was important to accommodate for the effects of inflation. This study adjusted dollar values of cost to a common year of reference (the year 2013). Reported dollar amounts were adjusted for inflation by using inflation conversion factors retrieved from Oregon State University’s Department of Political Science at https://liberalarts.oregonstate.edu/spp/polisci/research/inflation-conversion-factors-convert-dollars-1774-estimated-2024-dollars-recent-year. This website utilizes the consumer price index (CPI) as reported by the United States Bureau of Labor Statistics. The CPI quantifies changes in the price of all goods and services purchased for consumption by households ("Consumer Price Index,” 2018). This includes fees (for things such as public services) and sales and excise taxes paid by the consumer but excludes income taxes and investment items.

Equation 1 illustrates the formula used when researched dollar values were adjusted to a common year of reference. The equation requires a dollar value (DV) as well as the CPI-based Conversion Factor (CF) for a given year. Table 3.1 lists conversion factors for a 20 year span, as retrieved from the Oregon State University’s Department of Political Science website (2019). For example, to convert dollars of the year 2000 to an equivalent amount of the year 2013, the dollar amount is divided by the CF for the year 2000.
\[ DV_{2013} = \frac{DV_x}{CF_x} \]  

(1)

Where:

\( DV_x = \text{Dollar Value in year } x \)

\( CF_x = \text{Conversion Factor for year } x \)

For example, $1000 of 2000 = $1353 of 2013 ($1000 / 0.739). Numbers will be rounded to four significant digits.

Table 3.1 Consumer Price Index Conversion Factors for years 1998 to 2017 Estimated to Dollars of 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>CF</th>
<th>Year</th>
<th>CF</th>
</tr>
</thead>
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APPENDIX C: 2016 SCIENCE KIT UPDATE FOR ELEMENTARY PRINCIPALS

To: Elementary Principals  
Cc: Assistant Principals  
From: Tony Srinthai, K-12 Science Coordinator  
Re: 2016 Science Update

This has been a productive year for elementary math/science specialists. I have enjoyed the opportunity to work collaboratively with our specialists. Together, we have re-worked our science kit delivery schedule, which was a necessary change. Short-term highlights of the revised schedule include: every school engaging with the same kits, at the same time. More importantly, the kits will arrive at a more appropriate point in the year (conceptually and logistically). We would also like to share long-term goals for k-12 science within the district:

- A common kit rotation establishing the foundation for cross-curricular, integrated units
- Supporting a concrete and vertically-aligned K-5 curriculum
- Using the kits as a foundation to craft district-created, standards-based units
- The gradual easing of PLC-dependence on kits

I look forward to partnering with teachers/PLCs and continued work with our math/science specialists to articulate our science curriculum. Our work aims to support a myriad of awesome things already in place at each of your schools. Please do not hesitate to contact me if you should have any questions and/or concerns.

Thank you!
Appendix C (Continued)

2016 Science Kit Update for Elementary Principals

*Proposed science kit rotation 2016-17*

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*note: Dual Language schools deviate at 2 points in the above*
Appendix C (Continued)

2016 Science Kit Update for Elementary Principals

*CHCCS Elementary Science - 4 year curriculum plan*

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Appendix C (continued)

2016 Science Kit Update for Elementary Principals

"CHCCS Elementary Science - 4 year curriculum plan (cont.)"

![Diagram showing 2018-2019 and 2019-2020 curriculum plans]
REFERENCES


Chapel Hill-Carrboro City Schools. (2012). *2012-2013 CHCCS Final Approved Budget*. Chapel Hill-Carrboro City Schools Board of Education.


The Education Trust. (2015). Funding gaps 2015: Too many states still spend less on educating students who need the most. Washington, DC.


