Secondary Mathematics Teachers' Curricular Reasoning and Adaptations of Pacing Guides

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A Capstone Project

Presented to

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Doctor of Education

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APPROVAL OF THE CAPSTONE PROJECT

This capstone project, *Secondary Mathematics Teachers' Curricular Reasoning and Adaptations of Pacing Guides*, has been approved by the Graduate Faculty of the Curry School of Education in partial fulfillment of the requirements for the degree of Doctor of Education.

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Table of Contents

Chapter I: Introduction

Mathematics teachers across the country enter the school year with regulations from their districts and states, some of which are new. They have to learn about new students, including their names, their prior knowledge, their various socio-cultural backgrounds, any academic, behavioral, and/or emotional issues they may have previously had with school, and any lingering prejudices they have against the subject (Lampert, 2001; McDuffie & Mather, 2009; National Research Council, 2000, 2001). Sometimes teachers even have new curricula, standards, technology, and/or materials to learn themselves. Even if they do not have a new curriculum to learn themselves, teachers have to strategize on how to best adapt the content standards for their new group of students. Before the first day of school, many teachers begin creating plans for lessons and learning experiences that will excite and motivate their students (Lampert, 2001; National Research Council, 2001). These teachers intend to teach their students to appreciate mathematics as a powerful way of analyzing and understanding aspects of the everyday world that they may not have noticed (National Research Council, 2001). As teachers get to know their students during the first few weeks of the school year, they adapt their lessons even more to make sure their students can find purpose in what they are learning (Lampert, 2001; National Research Council, 2000, 2001; Pring et al., 2009).

There are many decisions teachers have to make every single day (Lampert, 2001). They must determine how to handle classroom management; how to set up a productive learning environment; how to answer questions about content; how to be a role model for their students; and how to assess their students' knowledge of material. Secondary mathematics teachers must also make many other decisions all of which affect their students' perceptions of mathematics. Some of these decisions are associated with curricula and what students learn in the mathematics

classroom. The goal of teachers is that their choices result in "good mathematics teaching," meaning that students develop "meaningful understandings of concepts and procedures as well as understandings about mathematics: what it means to 'do' mathematics and how one establishes the validity of answers, for instance" (Ball, 1988, p. 2).

Mathematics teachers in Virginia public schools look to the Virginia Department of Education Standards of Learning as a way to determine the minimum content standards expected for their course(s); these standards are discussed in more detail later in this chapter. The standards are formulated as statements about what students should know and be able to do by the end of the academic year. Some teachers view these standards appropriately as minimum requirements and teach much more mathematics than is stated in the standards. Other teachers find it difficult to address all of the content expected by these standards in a manner that leads to students gaining a strong conceptual understanding of the material (National Research Council, 2000). This difficulty could be for a variety of reasons, including students missing pertinent pre-requisite knowledge, specific learning challenges, school calendar restrictions, students missing school because of health problems, and weather interference. It could also be because some teachers' lack mathematical understanding themselves. Whatever the reason, it leads to dilemmas for teachers in terms of how and where to spend their teaching time.

Virginia Standards of Learning

The Virginia Department of Education (VDOE) created the Standards of Learning (SOLs) to "establish minimum expectations for what students should know and be able to do at the end of each grade level in…mathematics" (VDOE, 2018a). The first set of SOLs for mathematics were approved in June of 1995 (VDOE, 2018b). Approximately every seven years, the SOLs are revised by the VDOE. Thus, there have been four different versions of the

mathematics SOLs: 1995, 2001, 2009, and the most recently adopted, 2016.

As stated, these standards are meant by the VDOE to be the minimum each student should learn in each grade level. The Mathematics SOLs cover courses that range from kindergarten through high school, including Algebra I and II, Geometry, Trigonometry, Computer Mathematics, Probability and Statistics, Discrete Mathematics, and Mathematical Analysis. The SOLs articulate the content the curriculum should include in the academic year. The standards provide a brief overview and group the topics in lists under section titles of "Number and Number Sense," "Computation and Estimation," "Measurement and Geometry," "Probability and Statistics," and "Patterns, Functions, and Algebra" (Cannady, et al., 2016).

A.3	The student will simplify a) square roots of whole numbers and monomial algebraic expressions; b) cube roots of integers; and c) numerical expressions containing square or cube roots.

Figure 1: Algebra I, Standard 3

The VDOE also provides Curriculum Frameworks for each course that has established SOLs. These frameworks provide more detail about each standard. For example, Figure 1 shows an excerpt from the Algebra I standards document. This simply states what the student is expected to be able to do at the end of the Algebra I course. When looking at the Curriculum Framework for this same standard, as shown in Figure 2, it is clear there is much more related factual information to assist teachers in determining what exactly students need to learn. This breakdown is provided for every standard in every mathematics course.

A.3 The student will simplify

a) square roots of whole numbers and monomial algebraic expressions;
b) cube roots of integers; and
c) numerical expressions containing square or cube roots.

Understanding the Standard	Essential Knowledge and Skills
• A radical expression in Algebra I contains the square root symbol ($\sqrt{\ }$) or the cube root symbol ($\sqrt[3]{\ }$). • A square root of a number a is a number y such that $y^2 = a$. • A cube root of a number b is a number y such that $y^3 = b$. • A square root in simplest form is one in which the radicand has no perfect square factors other than one. • The inverse of squaring a number is determining the square root. • Any non-negative number other than a perfect square has a principal square root that lies between two consecutive whole numbers. • A cube root in simplest form is one in which the radicand has no perfect cube factors other than one. • The cube root of a perfect cube is an integer. • The cube root of a nonperfect cube lies between two consecutive integers. • The inverse of cubing a number is determining the cube root.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Express the square root of a whole number in simplest form. (a) • Express the principal square root of a monomial algebraic expression in simplest form where variables are assumed to have positive values. (a) • Express the cube root of an integer in simplest form. (b) • Simplify a numerical expression containing square or cube roots. (c) • Add, subtract, and multiply two monomial radical expressions limited to a numerical radicand. (c)

Figure 2 Curriculum Framework- Algebra I, Standard 3

The Curriculum Framework is not a curriculum in itself, though. It does not guide teachers on when to teach each topic, how long to spend on the various topics, or how to assist students in understanding the material for themselves. Nor does it provide suggestions for formative or summative assessment, support for teachers in terms of teacher notes, or additional resources for teachers to use when teaching the material, all of which are commonly found in a curriculum. The Curriculum Frameworks should be used by mathematics teachers, mathematics specialists, administrators, and district mathematics leaders when considering how to design instructional experiences. The Frameworks can be useful when creating pacing guides to determine the order in which the content is taught and how long should be spent on each topic.

Pacing Guides.

A pacing guide, sometimes referred to as a pacing calendar, curriculum map, scope and sequence, instructional calendar, or instructional road map is intended by school districts to provide teachers with guidance on arranging the content presented in the SOLs in a logical progression (Stefano, 2018). Every district makes their own pacing guide for their teachers. An example of a pacing guide is provided in Appendix B. The guides are what the writers believe to

be the best, most common, or most useful, organization of content for the students in their district. Each pacing guide is specific to a grade level or course area, such as fourth grade mathematics or geometry, and provides teachers with the information about the order of topics and how long to spend on each topic. Many times teachers, or teams of teachers, create pacing guides. Often, mathematics specialists and district mathematical leads create the pacing guides for teachers (Bauml, 2015; David, 2008). These decisions are frequently made by considering teachers' suggestions and reflections from previous years of teaching (Bauml, 2015). The pacing guides are typically meant to reflect the curriculum and standards and the students with whom they are working.

The aim, perhaps optimistic, of the pacing guides is that every student is exposed to at least all of the skills and knowledge deemed important as stated in the SOLs. There are benefits and disadvantages of encouraging all mathematics teachers across one district to follow the same pacing guide (Bauml, 2015). These guides can help teachers who are new to the profession or their content area by assisting them with some of the burden of determining in what order to teach specific content and approximately how much time to spend on each topic. However, pacing guides can also make some teachers feel as though they have to keep a certain pace of instruction and are bound to a calendar of when to teach specific content (Bauml, 2015; David, 2008). Some teachers may find this restricting and feel as though they cannot adapt to their students' needs.

Personal Experience.

In my experience, as a high school mathematics teacher in Virginia, pacing guides have not always been very useful. I would look at the pacing guide provided by my district at the beginning of each school year and immediately know that I could not keep the same pace as

envisioned by the district or Virginia Department of Education. While my colleagues and I followed the suggested sequencing of topics, we did not move as quickly as the pacing guide recommended. This was because I knew I would have to go back to teach, or reteach, content my students did not remember from previous mathematics classes and provide more time on the new material typically difficult for students to learn in hopes that my students had a strong understanding. There would also be school events such as pep rallies, required standardized testing that disrupted the school day such as the PSAT exam, students missing school for a variety of reasons, and other cancellations of class which affected when and how quickly I could move through the material.

By having to make these adaptations to the timeline suggested by the pacing guide, I also knew that there would be material that I would not have a chance to teach by the end of the year, which is a result of an over-packed curriculum. Therefore, I had to make decisions about what mathematics content to teach my students. When making these decisions, I had to consider many different aspects that make up and affect student learning and my students' needs in general. I had to consider what knowledge my students had before they entered my classroom and their previous feelings towards mathematics. I would also consider the course as a whole and think about what I felt were the key points my students needed to know in order to be prepared in future mathematics classes and their lives outside of school. For example, when teaching Algebra I, I believed that solving equations was a key aspect of the course and essential for future learning. Therefore, I stressed this aspect of the content and tried to make sure my students were successful with this material throughout the year.

I also considered the end-of-course exam and the topics represented. I compared the conceptual and procedural knowledge that made up many questions on the assessment to those

that made up only a few questions. For example, in geometry, formulas for finding the surface area and volume of three-dimensional objects were provided to students when they took the exam. This was also a topic on which there were only one to three questions in total. Therefore, I did not spend as much time on this topic as compared to angle relationships, for example, because I felt confident in my students' abilities to substitute provided values into the formulas. If they did miss these questions, I also knew it would not put them at a major disadvantage for passing the exam.

About a month before the end-of-course examinations, though, I would stop teaching new content and switch to helping students determine how to solve tasks on material not covered yet. As a class, we discussed test-taking strategies, such as how to eliminate answers that were not reasonable given the context of the question and skipping questions they did not know at all to come back to later. The pacing guide provided by my district did not set aside any time to review material for the end-of-course exam or to discuss these strategies. I also shared insights I had about the exam with my students. For example, throughout the year I stressed to students that they could not trust a picture to portray some information accurately. For instance, an angle might look like it measured 90 degrees, but the students should only believe it was a right angle when told so in the problem. However, on the end-of-year exam, pictures are correct, and, if an angle appears to be a right angle, it is. Because I had made decisions about providing more time than suggested by the pacing guide for certain topics and for teaching missed material from classes that preceded mine, I knew the students would face questions on material that we had not discussed. These choices of when to teach background material for my course that was not articulated in the SOLs, when to spend more time on topics than suggested by the district pacing guide on a topic, and what topics to spend little time on are ones I had to make as the teacher.

There are other mathematics teachers who had similar experiences. One colleague at a high school in a different district said she tried to follow the pacing guide provided by her district. However, she and her fellow mathematics teachers at her school had to "slow down in the beginning of the year to make sure [the students] had a strong foundation which would cause [the teachers] to make hard decisions when pressed for time before the SOL [exams]" (D. Baylor*, personal communication, September 12, 2018). D. Baylor and her colleagues made the choice to spend more time on material at the beginning of the school year knowing that they would not be able to teach all the topics before the SOL exams. However, they felt that if the students knew the topics from the beginning of the course well, they would be able to understand later topics more fully. These decisions are not easy for mathematics teachers, but they make them with the best intentions for students, taking into account students' needs.

Mathematics teachers are constantly trying to make the best decisions for their students. They are working to fill the gaps between what the VDOE expects of them, what their district expects of them, and what they can successfully accomplish in their classrooms. Teachers must use their unique knowledge about their students and content in order to make the best decision possible.

Mathematical Knowledge for Teaching

"The effectiveness of mathematics teaching and learning is a function of teachers' knowledge and use of mathematical content, of teachers' attention to and work with students, and of students' engagement in and use of mathematical tasks" (National Research Council, 2001, pp. 8 – 9). Effective mathematical teaching does not simply come from a teacher knowing all the mathematics they need to teach. They must also know how to work with students and use

* All names have been changed to pseudonyms to protect anonymity.

the content described in the SOLs to create a curriculum to which students can relate. This ability of teachers is called pedagogical content knowledge (PCK), a term coined by Shulman in 1986. PCK is knowledge and "understanding of what makes the learning of specific topics easy or difficult [for students]: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons" (Shulman, 1986, p. 11). Another way to describe PCK is the teachers' grasp of the "blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987, p. 8). It is how teachers in any subject make their content accessible to students.

Ball and colleagues (2008) expanded upon Shulman's concept of PCK to define Mathematical Knowledge for Teaching (MKT), displayed in Figure 10 in chapter 2. This concept describes the "mathematical knowledge needed to carry out the work of teaching mathematics . . . [It is] concerned with the tasks involved in teaching and the mathematical demands of these tasks . . . and demands an understanding of the content of the school curriculum" (Ball, Thames, & Phelps, 2008). MKT will be discussed more in the literature review in the following chapter.

Written and Enacted Curricula

According to current scholarship (Null, 2017; Wilson, 2005) there are multiple types of curricula. Table 1, an adapted table from Wilson (2005, pp. 2 – 4), provides definitions of two of these types of curricula pertinent to this study, the *Written Curriculum* and the *Enacted Curriculum*. Teachers are constantly moving between these two types of curriculums (National Academies of Sciences, Engineering, and Medicine, 2018; National Research Council, 2001). I investigated the curricular reasoning teachers engage in when they move, or do not move,

between these two types of curricula while using pacing guide(s) provided by their district.

Type of Curriculum	Definition
The Written Curriculum	It is simply that which is written as part of formal instruction of schooling experiences. It may refer to a curriculum document, texts, films, and supportive teaching materials that are overtly chosen to support the intentional instruction agenda of school. Thus, the overt curriculum is usually confined to those written understandings and directions formally designated and reviewed by administrators, curriculum directors, and teachers, often collectively.
The Enacted Curriculum	The formal curriculum comprises those things in textbooks, and content and concepts in the district curriculum guides. However, those formal elements are frequently not taught. The curriculum-in-use is the actual curriculum that is delivered and presented by teachers.

Table 1, Definitions for the Written and Enacted Curricula
(Wilson, 2005, p. 2)

Teachers use their MKT to determine what learning experiences they will provide their students. As Stein and Smith (2010) stated, "Curriculum does not influence students' learning directly but rather, unfolds in a series of temporal phases from the printed page [*the written curriculum*], to the teachers' plans for instruction [*the intended curriculum*], to the actual implementation of curriculum-based tasks in the classroom [*the enacted curriculum*]" (p. 353, emphasis added). The written curriculum in Virginia mathematics classrooms begins with the SOLs, the minimum that the Virginia Department of Education expects all students to learn by the end of the school year. However, teachers must determine how to teach their students this material. They use their MKT to navigate these standards and other pressures inside and outside the school to decide what will be taught, as displayed in Figure 3. For example, geometry teachers can access the standard on logic and reasoning, portrayed in Figure 4a, and the curriculum framework for the same standard, displayed in Figure 4b. They hopefully use this information, along with any information provided in the pacing guide, to determine how they will teach students to understand and conceptualize this content. Some teachers use hand motions, while others have students write stories using these various types of statements.

Whatever method(s) they use, it is in the effort to move students to understanding the material.

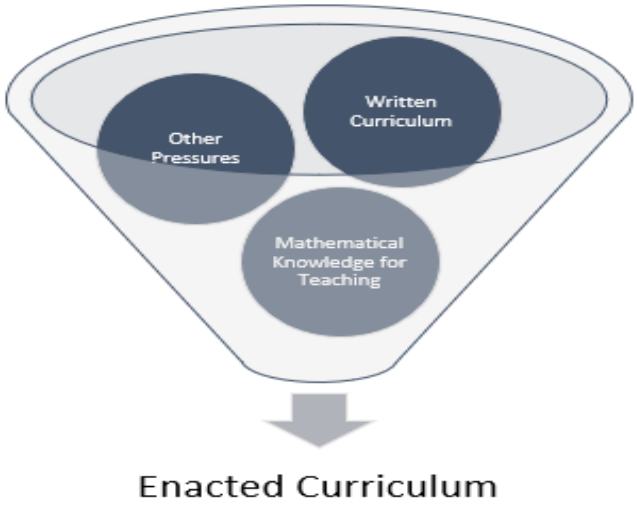

Figure 3, The Combination of Written Curriculum, MKT, and Other Pressures to Result in the Enacted Curriculum

G.1	The student will use deductive reasoning to construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include a) identifying the converse, inverse, and contrapositive of a conditional statement; b) translating a short verbal argument into symbolic form; and c) determining the validity of a logical argument.

Figure 4a, Geometry, Standard 1

G.1 **The student will use deductive reasoning to construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include**
a) identifying the converse, inverse, and contrapositive of a conditional statement;
b) translating a short verbal argument into symbolic form; and
c) determining the validity of a logical argument.

Understanding the Standard	Essential Knowledge and Skills
• Inductive reasoning, deductive reasoning, and proof are critical in establishing general claims. • Deductive reasoning is the method that uses logic to draw conclusions based on definitions, postulates, and theorems. • Valid forms of deductive reasoning include the law of syllogism, the law of contrapositive, the law of detachment, and the identification of a counterexample. • Symbolic notation is used to represent logical arguments, including the use of $\rightarrow$, $\leftrightarrow$, $\sim$, $\therefore$, $\wedge$, and $\vee$. • The law of syllogism states that if $p \rightarrow q$ is true and $q \rightarrow r$ is true, then $p \rightarrow r$ is true. • The law of contrapositive states that if $p \rightarrow q$ is true and $\sim q$ is true, then $\sim p$ is true. • The law of detachment states that if $p \rightarrow q$ is true and p is true, then q is true. • A counterexample is used to show an argument is false. • Inductive reasoning is the method of drawing conclusions from a limited set of observations. • Proof is a justification that is logically valid and based on initial assumptions, definitions, postulates, theorems, and/or properties. • Logical arguments consist of a set of premises or hypotheses and a conclusion.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the converse, inverse, and contrapositive of a conditional statement. (a) • Translate verbal arguments into symbolic form using the symbols of formal logic. (b) • Determine the validity of a logical argument using valid forms of deductive reasoning. (c) • Determine that an argument is false using a counterexample. (c)

Mathematics Standards of Learning Curriculum Framework 2016: Geometry Page 1

Figure 4b, Curriculum Framework- Geometry, Standard 1

This "thinking process that teachers engage in as they work with curriculum materials to plan, implement, and reflect on instruction" is called *curricular reasoning* by Breyfogle, McDuffie, and Wolhuter (2010, p. 308), and is related to PCK, and MKT when discussing mathematics classes specifically (Ball et al., 2008). Teachers work through curricular reasoning by deciding what they will be doing in their classrooms with their students (National Academies of Sciences, Engineering, and Medicine, 2018; National Research Council, 2001). Teachers think about their students' backgrounds, previously learned knowledge, and preconceptions about mathematics when making these decisions. Teachers use all of this information about their students while considering four important questions, as stated by Beyfogle et al. (2010):

> "• What are the important mathematical concepts and processes for today's lesson, this unit, and this year?
> - What do my students already know about these ideas?
> - Do the district-adopted curriculum materials align with the grade-level expectations?
> - In what ways will I need to adapt, supplement, or omit portions of the curriculum materials to meet the needs of the students and attend to grade-level expectations?" (p. 307).

Teachers are often thinking about questions in more depth, such as, "To what depth do my students already know, or think they know, information about this topic?" Many teachers use the answers to all of these possible questions to design their lesson plans and learning experiences in hopes that the students will understand the material (Breyfogle et al., 2010; National Academies of Sciences, Engineering, and Medicine, 2018; National Research Council, 2001).

Occasionally these design decisions include teaching content that is not included in the SOLs for the specific course. Teachers might go beyond the expectations of the SOLs and teach their students more in depth and/or applications of the mathematics. In other cases, teachers may

include material students have misconceptions about or information they missed and/or were never taught in their previous classes. For example, some students leave elementary mathematics with the misconception that multiplication always leads to a larger number. Teachers may also find that they need to spend more time than the pacing guide suggests on a given topic. This could be for a variety of reasons, including the need to provide students with more time to grapple with a concept or the realization that students still have misconceptions about a topic and that time is needed to go back to reteach. When these situations occur, teachers find themselves making curricular decisions. The teachers know that by slowing down and/or providing missing background information, they are losing instructional time necessary to cover all the content in the written curriculum. Therefore, the enacted curriculum does not always reflect what the writers of the SOLs had intended. This adaptation by teachers is done on behalf of the students and is constantly being done. The teachers make these decisions, though, in hopes that the students will better understand material that is taught (Shulman, 1986, 1987).

Statement of Problem

The best teachers are able to adapt their teaching to each group of students in their classroom (National Academies of Sciences, Engineering, and Medicine, 2018; National Research Council, 2000, 2001). These teachers make choices about what learning experiences will best help their students learn the material. Teachers must also determine how the students' background knowledge will help or hinder them in achieving the goals for each class (McDuffie & Mather, 2009; National Research Council, 2000). At times this can mean pausing in teaching new content to review material they learned, or were supposed to learn, in previous mathematics classes. A teacher may also decide to spend less or more time on each topic compared to the pacing guide based on students' understanding of the material and the teachers' own beliefs

about mathematics (Bauml, 2015).

These decisions affect whether teachers keep pace with the mathematics pacing guide provided by their district. Districts create pacing guides as a resource to advise teachers on the order to teach the content and the amount of time to spend on each knowledge and skill (Stefano, 2018). The choices made by teachers determine how the written curriculum changes to the enacted curriculum and if there are any differences between the two. Many teachers face tension between moving on in terms of knowledge and skills and spending more time on certain topics to encourage conceptual understanding. I have been unable to find any empirical evidence that shows that if teachers keep pace with the pacing guide then their students will learn more than if teachers do not keep the suggested pace, or vice versa. This study considers the problem of practice of how teachers use curricular reasoning to balance the need to cover all the topics in the written curriculum versus teaching a few topics well.

Research Questions

To guide the investigation of this study, I posed the following research questions:

1. What benefits and concerns do teachers find with pacing guides?
    a. How do these benefits/concerns vary with the experience of the teacher?
2. What changes do teachers make regarding curricular pace and sequencing relative to what is stated in pacing guides given by the school district?
    a. What are the bases for these decisions?
3. How does teacher experience affect their use and/or adaptation of pacing guides?

Purpose of Study

The purpose of this study is to examine how some mathematics teachers in Virginia use and adapt pacing guides provided by their districts and what curricular reasoning process

teachers go through to make these adjustments. While there is research investigating the differences between the written curriculum and the enacted curriculum, there are no published studies exploring how the pacing guides affect these differences. There also is a gap in the research examining how teachers move from the provided pacing guides to their enacted curriculum. This study will work to fill those gaps. The problem of practice I will be investigating with this study is how teachers move between the written, intended, and enacted curricula as portrayed by the pacing guides. In my opinion there is too much material in the mathematics curriculum. Teachers are expected to teach all of it well, however that is not always feasible. Some teachers must decide if they will introduce all of the topics to their students or only choose some of the topics to teach well.

Another reason this study is beneficial is to examine if and how pacing guides are used by teachers. I am looking to see what occurs in the classroom – if teachers do use the pacing guides, do they adhere to them? If they do not, what are their reasons for adapting? How do teachers reason through their decisions to keep with the pacing guide or to move away from it? How do they use their MKT in making these decisions? I expect that veteran teachers do not follow the pacing guide as closely as new teachers. I believe this is because veteran teachers use their MKT to determine which topics students need more time working with and which topics can be covered quickly. These veteran teachers are able to use this knowledge to make adjustments as they move between the different types of curricula.

Conceptual Framework

The conceptual framework guiding this study is adapted from Stein and Smith (2010), displayed in Figure 5. The focus of my research is on how teachers use curricular reasoning to move between these different curricula to encourage student learning. The *written curriculum* is

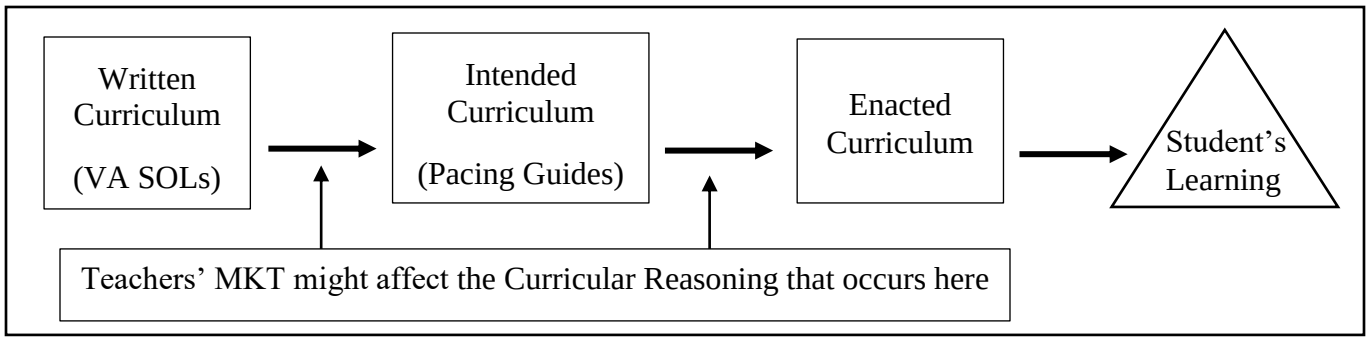

Figure 5, Conceptual Framework
(Adapted from Stein & Smith, 2010, p. 352)

represented by the VA SOLs for this study. It is the skills and knowledge VDOE has determined students should learn in each mathematics class. The pacing guides represent the *intended curricul*um for the purposes of this study. The pacing guides delineate the suggested order in which the topics are to be taught and the amount of time spent on each topic as suggested by the district. Finally, the *enacted curriculum* is what actually occurs in the classroom. This curriculum is the teachers' choice because he/she is the one making the final decisions for the students in the mathematics class. It is the thinking, conceptualizing, and actions that occur between these levels of curricula that are of interest for this proposal. For example, when algebra I teachers are working with their students on simplifying square roots and cube roots, as shown in Figures 1 and 2 above, they might choose to spend time teaching/reviewing how to find factors of a number. This is not listed as part of the Algebra I standards; however, it is a necessary skill in order to be successful with simplifying square roots and cube roots. Some teachers may also decide to teach exponent rules prior to teaching simplifying roots. These decisions, or curricular reasoning, are at the center of this proposal.

However, this process is not unidirectional as represented in Figure 5. There are many moving parts that make up what occurs in the mathematics classroom (National Academies of Sciences, Engineering, and Medicine, 2018; National Research Council, 2001). The written curriculum (as portrayed through the standards), the intended curriculum (displayed through the

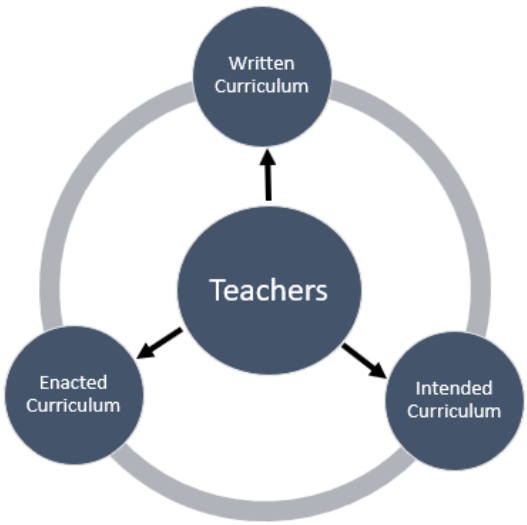

Figure 6, Written Curriculum, Intended Curriculum, Enacted Curriculum, and Teachers Interrelated

pacing guides), and the enacted curriculum all affect one another, as represented by the circle in Figure 6. I was interested in seeing what the relationships are between these various parts and how teachers move between them, as represented by the arrows in Figure 7. I was also wondering if and how veteran teachers make different adaptations between these various types of curricula compared to their novice colleagues. As stated earlier, the problem of practice I will be examining in this study is how teachers move between the written, intended, and enacted curricula, especially when considering if they should teach all of the material or only some of it deeply. I expect veteran teachers are able to anticipate students' needs more than novice teachers, and thus are able to make more of the necessary adjustments when moving between the written, intended, and enacted curricula.

Definition of Terms

Curricular Reasoning	• The "thinking process that teachers engage in as they work with curriculum materials to plan, implement, and reflect on instruction" (Breyfogle, McDuffie, and Wolhuter, 2010, p. 308) • Similar to PCK and MKT
Enacted Curriculum	• What is actually taught • The information students are presented
Intended Curriculum	• The information and order in which the district expects teachers to teach their students • Pacing guides represent the intended curriculum for this study
Mathematical Knowledge for Teaching (MKT)	• An expansion from PCK by Ball et al. (2008) • Knowledge mathematics teachers need to instruct their students effectively • Broken into two main categories: content knowledge and pedagogical content knowledge. ○ These categories are broken down even further: Content knowledge is made up of common content knowledge, horizon content knowledge, and specialized content Pedagogical content knowledge is made up of knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum
Pacing Guide	• Provided by individual school districts • Specify the order in which topics should be covered • State the amounts of time the creators believe should be spent on each topic • Unique for each course
Pedagogical Content Knowledge (PCK)	• Knowledge unique to teachers to create lessons and curriculum to which students can relate • "Understanding of what makes the learning of specific topics easy or difficult [for students]: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons" (Shulman, 1986, p. 11).
Standards of Learning (SOLs)	• Created by the Virginia Department of Education (VDOE) • Establish the minimum expectations for what students will know and be able to do by the end of the course. • Provide guidance to teachers as to what content they are expected to teach during the academic year • The written curriculum
Written Curriculum	• What is written down as the formal part of schooling • The content students are expected to learn in the course as stated by the VDOE in the SOLs

Chapter II: Literature Review

The previous chapter established the need to understand how mathematics teachers in Virginia use and/or adjust pacing guides for their classes. The following chapter is a review of available literature. The collection of literature for this study was systematic. I began with the Google Scholar search engine and the University of Virginia catalog search engine, looking for articles and/or books on pacing guides and scope and sequence. This led to only a few articles, discussed later in this chapter. My search was then widened to the movement between different types of curriculum. I included research on teachers' movement between written, intended, and enacted curriculum because I started questioning *how* and *why* teachers make the decisions to adjust the pacing as compared to the provided pacing guides. I tried to focus solely on articles and/or books related to mathematics curriculum and teachers, yet if an article outside of the mathematics field seemed relevant, it was included. I decided an article was pertinent if it included discussion on how teachers adapted pacing guides in their teaching.

As my proposal began to take shape, I also began to look for articles and/or books on standards movements. The addition of articles and books on standards movements was to establish part of the history leading to present day education. There were scope and sequence guides prior to standardized tests. However, many of these guides were only a list of topics students should learn; they usually did not include essential understandings or skills, nor did they include suggested amounts of time to spend on each topic (Beyer, 1988; Ediger, 1990; Maker, 1986). Standards movements seemed to have increased the development of pacing guides (Lauen & Gaddis, 2016; Ravitch, 1995). As shown in Figure 7, standards led to standardized tests and accountability for teachers and schools. This then in turn led to pacing guides for teachers to help determine what to teach and in what order to teach the material. Finally, because some standards

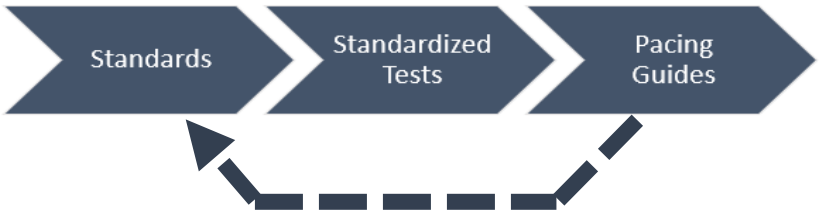

Figure 7, Flow between Standards, Standardized Testing, and Pacing Guides

are written by and/or with the input of teachers, pacing guides can affect what is viewed as attainable and thus should be in the standards. With the introduction of standards, school districts were being held accountable to standards, thus they had to hold the teachers accountable to teaching the content. I also began researching Pedagogical Content Knowledge (PCK), and more specifically, Mathematical Knowledge for Teaching (MKT). This was because I believe mathematics teachers use this knowledge in order to make curricula adaptions to best meet the needs of their students. I hypothesize that veteran teachers adapt pacing guides more than novice teachers because of their PCK/MKT. They use the knowledge they have developed over years of teaching in order to determine what they believe is the most effective way to teach material in order for students to understand and learn. This does not always follow what pacing guides state, in terms of order the content is taught in and/or the amount of time spent on each topic. It incorporates the teachers' knowledge of mathematics and best teaching practices and students' prior knowledge of the material.

Even though there is not much literature on pacing guides, there is research literature in related aspects of planning for instruction and curricular reasoning, including adoption of curriculum, scope and sequence, and how teachers move between written and enacted curriculum, all of which are relevant to teachers' implementation of pacing guides. This chapter examines this research as it pertains to teachers' movement between written curriculum, intended curriculum, and enacted curriculum. Any available literature on pacing guides will be highlighted. Identification of gaps in the literature will be provided at the end of the chapter as

well.

I begin this chapter by reviewing available literature on standards movements. Second, I describe curriculum and the various forms curriculum can take. Next, I discuss pedagogical content knowledge, focusing on mathematical knowledge for teaching and curricular reasoning. Finally, I review what little literature is available on pacing guides. There is a gap in the literature on pacing guides and how they are used by mathematics teachers which this proposal hopes to fill.

Standards Movements

As stated earlier, educational standards led to standardized tests and greater accountability for teachers and schools, which then led to pacing guides for teachers (Lauen & Gaddis, 2016; Ravitch, 1995). I believe pacing guides have evolved from some teachers needing assistance on how long to spend on a topic as well as what order to teach the content. Other teachers use pacing guides as a way to plan out their year. As accountability measures have grown, the usefulness of pacing guides, and some believe mistrust in teachers' abilities to make these decisions themselves, has also grown (Taubman, 2009).

Merriam-Webster (2018) online dictionary has nine different definitions for the word "standard", two of which pertain to what is meant when the word "standard" is used in education:

> "3: Something established by authority, custom, or general consent as a model, or example . . .
> 4: Something set up and established by authority as a rule for the measure of quantity, weight, extent, value, or quality."

Standards in education represent both the goals teachers and students are working towards and the measure of their progress to that goal (Horn, 2004; McInerney, Van Etten, & Dowson, 2007; Ravitch, 1995). Because education is not mentioned in the constitution as a right of the federal

government, educational standards are created at the state level. Pacing guides are then created by school districts in response to the state content standards.

Pacing guides, or pacing calendars, have sometimes been referred to as the "scope and sequence" of the material or curriculum (Beyer, 1988; Ediger, 1990; Maker, 1986) although this term has largely been left in the 20th century. The "scope" refers to the breadth or extent of the content being taught or "the understandings, skills, and values that are the goals of the program" (Maker, 1986, p. 151). The "sequence" term applies to when or the order in which the content might or should be taught. However, some scope and sequence guides were not as detailed as current pacing guides (Ediger, 1990). Most notably, they did not include suggestions for the amount of time teachers should spend on each topic. Since this study is proposing to research how mathematics teachers in Virginia are currently engaging in *curricular reasoning* (the pedagogical reasoning teachers think through as they adapt materials for their students) when working with standards and pacing guides, it is important to understand where it came from and some of the events which led to where we are today.

History of Standards

Standards did not simply appear one day as guidance on what content teachers were expected to instruct their students on. They grew out of a public and political movement for more accountability of schools, teachers, and students. According to Taubman (2009), Herrera and Owens (2001), Horn (2004), McInerney, et al. (2007) and Ravitch (1995), standards have been around for decades. They may have been discussing scope and sequence guides, however they only referred to general standards. Some researchers (e.g. Ravitch, 1995) go back in history, before WWI, to demonstrate that there were standards for schools, teachers, and students. The standards then were set by colleges and universities in terms of what was expected of students

who wanted to enroll (Horn, 2004; Ravitch, 1995).

Other researchers (e.g. Taubman 2009) note that businesses also had influence on education standards. Some business owners did not feel as though schools were producing students who were well-educated so that they would become valuable workers. These owners believed that in order for their companies to succeed in the world economy, they needed higher skilled workers. Taubman (2009) argued that the move by businesses to make schools and education more like the business world signaled a distrust of teachers. According to Taubman, standards movements beginning in the 1980s demonstrated a belief that teachers were not fully succeeding at their jobs and needed guidance to determine what and how to teach. There was an assumption by these business owners that teachers did not know how to move their students forward in learning pertinent information. Twenty-first century skills and "college and career readiness" (Common Core State Standards Initiative, 2019; VDOE, 2018) were included as part of standards in the United States after encouragement from business owners.

This standards movement in the 1980s was further fueled by the publication of *A Nation at Risk* in 1983, a report by President Ronal Reagan's National Commission on Education Excellence. This report stated that America's schools were failing and quickly falling behind other countries (Horn, 2004; McInerney, et al., 2007; Ravitch, 1995; Taubman, 2009). By providing content standards, it was believed that teachers would use this information to move their students further ahead, leading graduates to be skilled workers and help grow the American economy.

The current education climate is a result of decades of education reform efforts (Horn, 2004; McInerney, et al., 2007; Ravitch, 1995; Taubman, 2009). Some of these reforms began at the university levels while others were from pressures by business owners and politicians.

Whatever led to standards, they are currently a reality for teachers.

Teachers Use of Standards

Lauen and Gaddis (2016) examined how teachers used standards and standardized tests to decide which students received most attention. They examined data before and after North Carolina increased the level of "rigor" of their mathematics and reading standards. Lauen and Gaddis noted that prior to increasing rigor, teachers were triaging in terms of which students would receive additional support in order to pass the standardized assessments. Teachers were providing this limited, additional support to students who were close to passing the assessments, but not to students who were either well above or well below the grade level expectations. Lauen and Gaddis found through examination of students' scores on end of course exams that the students who benefitted from a supposed increase of rigor of the standards were the middle students. Those who were previously well below and well above the grade level expectations demonstrated negative effects after the change in standards. Lauen and Gaddis argued this is because teachers had to do even more triaging and selection of where to allocate resources after the increase in standards. Thus, the increase in rigor in standards did not benefit or make sure all students were held to the same level.

Engel, Claessens, Watts, and Farkas (2016) also considered what is occurring in kindergarten mathematics classrooms, compared to standards that were provided. They found that teachers were spending quite a bit of time on lower level topics, such as basic counting and shapes. Even though many students already were familiar with this information before beginning kindergarten, as indicated by their performance on the achievement tests, teachers felt as though they should focus on these topics because of the emphasis from the standards. Engel et al. also discovered that when teachers spent more time on higher level topics, such as basic addition and

subtraction, there were learning gains for all students. These findings are important for this study because it highlights the importance of teachers knowing students' prior knowledge and incorporating it into their teaching. If students already know basic counting and shapes, teachers need to be capable and willing to move on to higher level topics. Thus, teachers should continue to encourage students to advance in their learning of mathematics.

The National Council of Teachers of Mathematics (NCTM) attempts to assist mathematics teachers in their planning and teaching. NCTM believes that standards should affect what teachers are doing but not be the only guiding force. NCTM was one of the first professional organizations to promote both content standards and standards for teachers.

NCTM Standards

Following the guidelines presented by NCTM in their publications of *Curriculum and Evaluations Standards for School Mathematics* in 1989, *Professional Standards for Teaching Mathematics* in 1991, and the *Taking Action: Implementing Effective Mathematics Teaching Practices* series in 2017, it is now favored for teachers to be more of a facilitator to assist students in discovering the mathematical information on their own. Teachers are encouraged to teach in a manner that every student gains a conceptual understanding of the material, not only those planning on enrolling in college (Herrera & Owens, 2001). NCTM recommends doing this through exploration and discovery by the students, encouraging mathematical dispositions and practices. This exploration by students takes longer than teachers simply lecturing about steps and theorems to memorize. These beliefs for teaching and learning mathematics may have a major impact on the problem under study with this proposal. This method of teaching can alter teachers' progress through the material, thus affecting whether teachers are able to keep with the pacing guide and requiring them to make decisions about which topics to cover and which to

skip.

To make these decisions teachers have to consider various aspects of curriculum. Curriculum can be defined in many ways depending on what is being examined. There have been many researchers (e.g. Cornbleth, 1984; Joseph, 2011; Marsh, 2009; Null, 2017; Wilson, 2005) over the past few decades who have written about these different forms of curriculum.

Multiple Ways of Categorizing Curricula

There are many different definitions of curricula and it is necessary to consider what each definition provides and what it is excluded (Marsh, 2009) because these definitions provide some views of how pacing guides are constructed and used. Some of these include (1) the *hidden curriculum*, such as messages students receive from the organization of the classroom and how to interact with others; (2) the *null curriculum*, which is what teachers choose not to teach, possibly giving the message that these topics are not as important; and (3) the *received curriculum*, or the information students actually learn.

When discussing curricula, it is also essential to clarify what definition each person is using. Null (2017) argued that curriculum is more than a list of topics, but is everything that occurs between and among students and teachers, including all the decisions teachers make when providing instruction to students. Like Marsh (2009), Null encourages the reader to ask important questions about what curriculum is and what it should be.

Various Types of Curriculum

Similar to Cornbleth (1984), Marsh (2009), and Null (2017), Wilson (2005) recognized and defined multiple types of curricula. For example, Wilson defines the *received curriculum* as "Those things that students actually take out of the classroom; those concepts and content that are truly learned and remembered" (2005, p. 4). Wilson's definitions are free of jargon. They

provided the basis for the definitions in the previous chapter and are used throughout this proposal.

Joseph (2011) also described multiple views of curricula. She highlighted two different models of curricula. The first model was of splitting curricula into the *explicit curriculum* (the content purposefully taught by the teacher), the *implicit curriculum* (the unofficial lessons, values, and opinions students learn), and the *null curriculum* (the information intentionally left out of the classroom). The second model separated curricula into the *official curriculum* (the curriculum expressed in the standards and/or pacing guides), the *taught curriculum* (the curriculum teachers teach in their classrooms), the *learned curriculum* (the curriculum students actually learn), and the *tested curriculum* (the curriculum that is tested on assessments). These two models are depicted below in Figure 8. Joseph (2011) stated, "that whenever we speak of

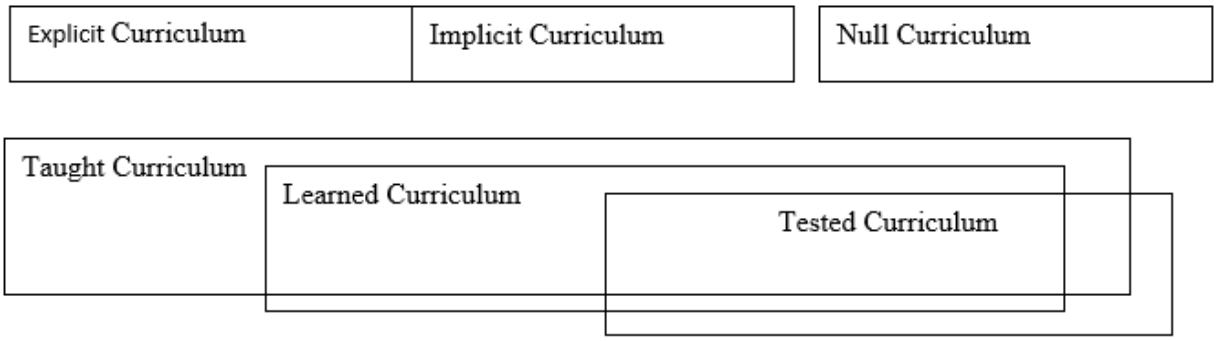

Figure 8, Two Models of Curricula According to Joseph (2011)

curriculum, we must ask, 'which curriculum?'" (p. 6). This proposal takes into account teachers' movements between the written or official standard curriculum supplied by the state as stated in the SOLs, to the intended curriculum provided by districts in terms of pacing guides, to the enacted curriculum in terms of what teachers actually spend time on in their classrooms.

Thompson and Senk (2010) discussed the concepts of *intended* versus *written* versus *enacted* curriculum in terms of what actually occurs in mathematics classrooms as they debunk four myths some hold about mathematics teaching. They stated, "Attempts to mandate a

curriculum may be made by district or state officials or other policymakers, but the results discussed here suggest that detailed information about what happens at the classroom level is crucially important" (Thompson & Senk, 2010, p. 261). It is important to study what is occurring at the classroom level to help determine how these mandates affect teaching, if they affect it at all. I am hoping to follow this guidance and collect information about what is happening at the classroom level and how teachers are making decisions to deviate from intended curriculum provided by school districts in the form of pacing guides when necessary.

Stein and Smith (2010) used their framework, an adapted form presented in Figure 9, as a lens for teachers and administrators to consider the enactment of curriculum. (I have added in students' prior knowledge as an additional explanation for transformation.) They, like others, argued that the written curriculum is not always what teachers teach or what students learn. Stein and Smith note that there are many factors which can influence students learning the curriculum.

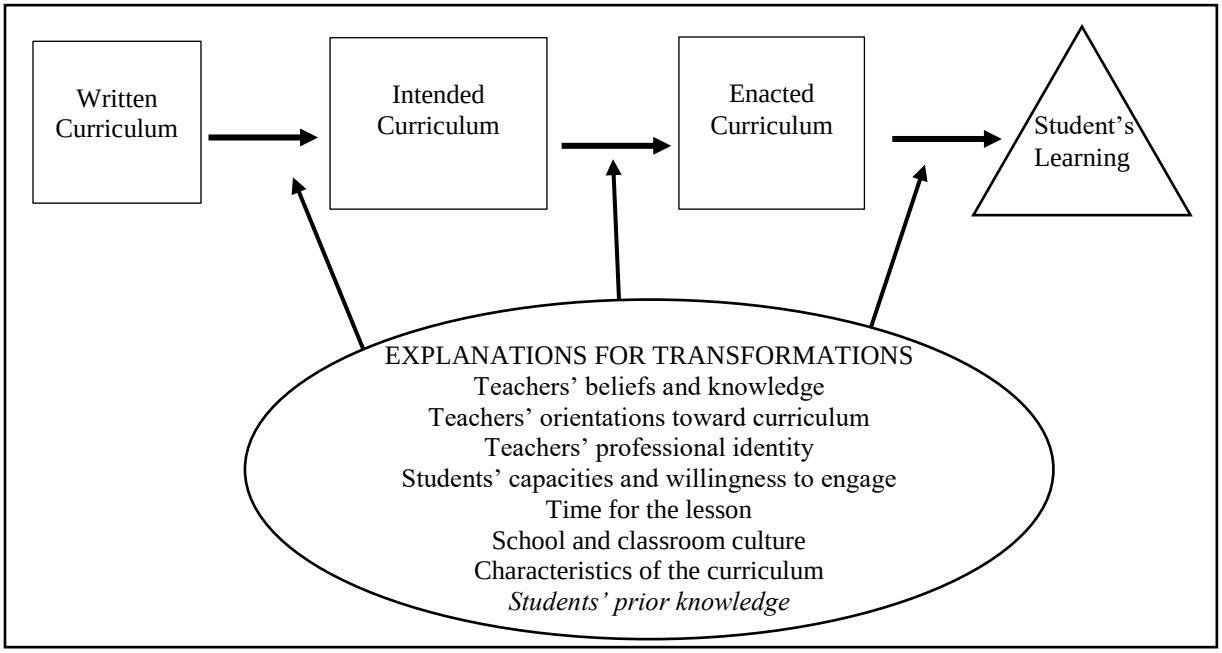

Figure 9, Temporal Phases of Curriculum Use
(Adapted from Stein & Smith, 2010, p. 352: Addition in italics)

These factors are what lead to the transformations when moving from one curriculum to another. The factors teachers control is what I intend to study. The framework provided by Stein and

Smith portrays the various phases between the written curriculum and student learning. Another adapted version of this diagram is part of the conceptual framework guiding this study, presented in the previous chapter, in Figure 6 on page 17.

When teachers move between different types of curriculum, for example from the written curriculum to the enacted curriculum, they must use knowledge that is unique to teachers. This knowledge, pedagogical content knowledge, is how teachers are able to make their content accessible to students and determine the best way to teach the information to their students.

Pedagogical Content Knowledge

Shulman (1986) presented and defined the differences between content knowledge, pedagogical content knowledge, and curricular knowledge. He explained how these three different types of knowledge are relevant to teachers, all of which are important parts of this study. Content knowledge is the facts, figures, formulas, definitions, dates, theorems, rules, strategies, terminology, and other important information about a discipline any person in that field would know. However, "We expect that the subject matter content understanding of the teacher be at least equal to that of his or her lay colleague, the mere subject matter major" (Shulman, 1986, p. 6). Curricular knowledge is the familiarity teachers have with materials that support the written and/or enacted curriculum, alternative representations and/or materials, and other subjects students are learning about. This curricular knowledge allows teachers to relate their content to other topics students are studying and discussing in other classes. Pedagogical content knowledge (PCK), includes knowing how and why some topics are easy or difficult for students, preconceptions and/or misconceptions students bring into the classroom with them, and the best ways of representing knowledge and skills to optimize students' understanding. As Shulman stated,

> "The teacher need not only understand *that* something is so; the teacher must further understand *why* it is so, on what grounds its warrant can be asserted, and under what circumstances our belief in its justification can be weakened and even denied . . . we expect the teacher to understand why a given topic is particularly central to a discipline whereas another may be somewhat peripheral" (Shulman, 1986, p. 6).

It is also Shulman's (1986) argument that PCK grows over time. This is why and how researchers discuss some of the differences between veteran teachers and novice teachers. I believe that teachers use their PCK when considering what skills and knowledge to spend more time on than suggested by pacing guides or when changing the order of instruction compared to the pacing guide.

All teachers, in every content area develop PCK through experience. Ball, Thames and Phelps (2008) used PCK and adapted it specifically for teaching mathematics. Each content area has specific PCK. However, because this study is focusing on secondary mathematics teachers, I will be concentrating on the PCK needed to teach mathematics.

Mathematical Knowledge for Teaching

Ball, et al. (2008) built on Shulman's (1986) concept of PCK to create what they call Mathematical Knowledge for Teaching (MKT), portrayed Figure 10. This, according to the authors, is the understanding mathematics teachers need of the content, the best representations, the common misconceptions held by students, and the ability to help students make connections between topics. Teachers need to know how to unpack mathematical topics in ways beyond what the average person using mathematics knows. This unpacking of mathematics is for the purpose of explaining mathematics in terms students can relate to both in terms of interests and prior knowledge. "Teachers must anticipate what students are likely to think and what they will find confusing" (Ball et al., 2008, p. 401). This comes from repeated experience with students and

knowing where they often have difficulties.

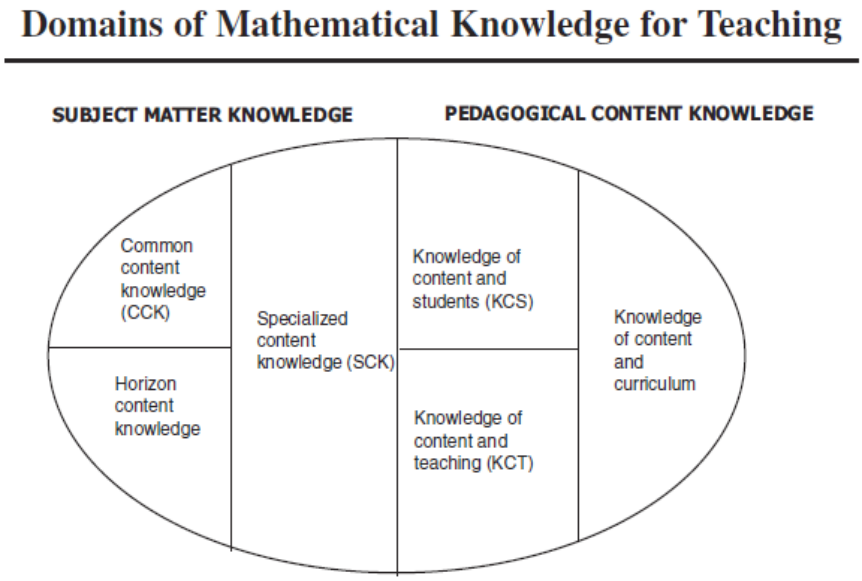

Figure 10, Domains of Mathematical Knowledge for Teaching
(Ball et al., 2008, p. 403)

One example of MKT is the specific sequencing of skills and knowledge teachers believe is best for their students. They use their knowledge about the mathematical content, how the mathematics builds on itself, where students often develop misconceptions, and the best way to teach the mathematics in order to determine in what order the information should be taught. I believe that veteran teachers are more likely to adjust pacing guides than their novice colleagues because they use their MKT. This is why veteran teachers are be included in research about pacing guides, not solely novice teachers.

Pacing guides are built around intended student knowledge - what conceptual, factual, and procedural knowledge students need in order to move forward in mathematics. Pacing guides typically do not have any information about teachers, teachers' knowledge, representations for teaching content, or connections teachers can make with students' prior knowledge nor other courses they are taking. Most pacing guides only include common content knowledge. Many pacing guides do not include horizon content knowledge - teachers with high levels of MKT will

know what topics students generally have learned before their course (however, it does vary by individual student), what topics are to come in future mathematics courses, and how to connect between all these topics. Even fewer pacing guides have information referring to the PCK side of Figure 10. Therefore, in my opinion teachers should use their MKT to implement pacing guides effectively, even if that means modifying the suggested pace and/or sequence.

Borko and Livingston (1989) discussed some differences between three expert mathematics teachers and three novice (student) teachers. They found that expert teachers were able to plan more efficiently, adapt to their students' needs better, and answer students' questions more fully than the novice teachers. None of these results are surprising considering this is related to MKT. Borko and Livingston recognized that there are important aspects of instruction that teachers learn with experience, i.e. MKT. Given all that is known about MKT (and PCK), it will be interesting to see the degree to which veteran teachers follow or deviate from pacing guides compared to new teachers, and what curricular reasoning they engage in.

McDuffie and Mather (2009) discussed teachers' use of MKT when beginning work with a new curriculum. This collaboration between McDuffie and two seventh-grade mathematics teachers in implementing a new mathematics program. Although mathematics programs and purchased curricula might make a difference in the use of pacing guides, I assume that they went into the authors' considerations of the use of pacing guides, therefore it is not part of my study. McDuffie and the mathematics teachers functioned as a professional development team (PDT) (much like professional learning communities) to discuss the various issues they were experiencing in their own classrooms. The two mathematics teachers said the PDT was extremely helpful when considering how to adapt the written and intended curriculum for their classes and students. They said they would probably not have been able/willing to make the

changes on their own the PDT decided on and which seemed to be beneficial for students. McDuffie and Mather argued that all teachers should have communities such as the PDT to work through curriculum reasoning and to discuss what is occurring in the classrooms. These communities can help teachers use their MKT (or PCK) to adapt the pacing guides as necessary for the students in their classes, if they do not do so already. Teachers who have this knowledge may not have the agency or confidence in themselves to use it. The communities described by McDuffie and Mather can boost teachers' courage to make adaptations to the pacing guide(s) necessary for their students' success.

Curricular Reasoning

These communities can lead to improved curricular reasoning by teachers. Breyfogle, McDuffie, and Wohlhuter (2010) reflected on curricular reasoning teachers partake in when they teach. Curricular reasoning is the process teachers go through when making decisions about what, when, and how to teach their content. Breyfogle et al. (2010) argued that curricular reasoning is and should be at the center of everything teachers do. They created a model, recreated in Figure 11, to demonstrate the relationships among curricular reasoning, curricular knowledge (Shulman, 1986), curricular vision, and curricular trust. According to Breyfogle et al., curricular reasoning is a part of MKT in the way teachers make decisions about what materials to use and how to help students grow in their mathematical understandings.

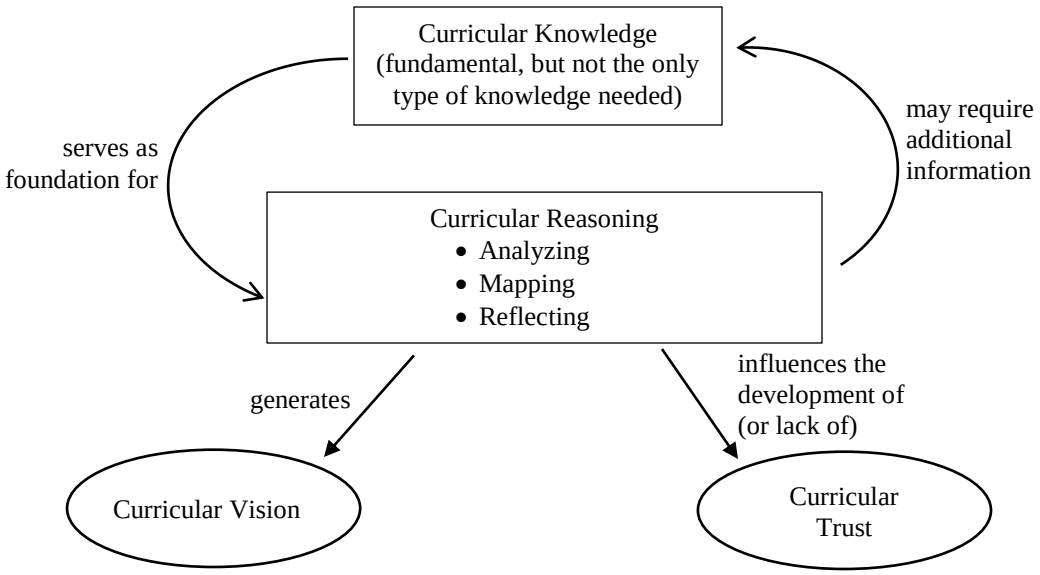

Figure 11, Relationships Among Curricular Reasoning, Curricular Knowledge, Vision, and Trust (Breyfogle et al., 2010, p.310)

There is no one definition of curricular reasoning, although many researchers (e.g. Bernard, 2017; Gadd, n.d.; Taylor, 2016) describe it. Dietiker et al. (2018) also created a framework for what they call "curricular noticing," recreated in Figure 12. In their framework, Dietiker et al. include *curricular attending*, *curricular interpreting*, and *curricular responding*. *Curricular attending* includes the skills teachers have with looking at the content in curriculum materials. These skills include the "searching, looking, locating, surveying, and other ways of visually taking in materials prior to their interpretation" (Dietiker et al., 2018, p. 525).

This leads to curricular interpreting, which is the process teachers go through to make sense of the material to which they attended. Curricular interpreting "includes connecting the ideas found in the curriculum materials with the teachers' mathematical knowledge for teaching, such as subject matter knowledge and pedagogical content knowledge (including knowledge of students, teaching and curriculum)" (Dietiker et al., 2018, p. 526. Finally, curricular noticing includes curricular responding. This is the process of making curricular decisions based on their interpretation of curricular materials. As displayed in Figure 12, this process is not unidirectional. Each of these parts affect one another and teachers are constantly going back and

forth between the parts.

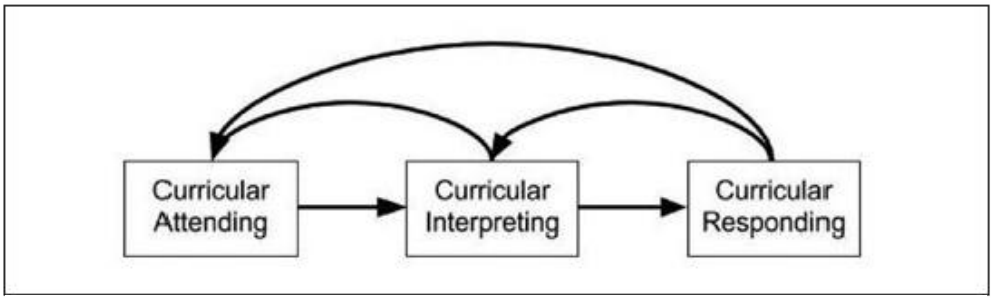

Figure 12, The Curricular Noticing Framework
(Dietiker et al., 2018, p. 527)

Teachers should use their MKT when determining how to use pacing guides. Teachers decide if their students need more background information than suggested by standards, more or less time on a topic than recommended by the pacing guide(s), and/or which topics will be skipped due to time restraints.

Pacing Guides

As stated earlier, the available scholarly literature on pacing guides is limited and dated. Pacing guides are meant to provide teachers with guidance on what order to teach skills and knowledge in and how long to spend on each topic. As discussed, some mathematics teachers use their MKT to adapt their teaching to each group of students.

David (2008) provided a summary of previous studies of curricula adaptation. Her main finding was "that pacing guides intensify pressure on teachers to cover all the material specified" (p. 87). David found that teachers generally deal with this pressure in at least one of four ways: (1) spending more time on topics tested compared to those that are not (aka teaching to the test); (2) using direct instruction that seems more efficient than student centered lessons; (3) lowering the cognitive demand of activities for students; and/or (4) prioritizing breadth over depth of material. David did note that pacing guides can be extremely helpful to new teachers, being the "primary source of information on what their school expects them to teach" (p. 87).

Use of Pacing Guides

Cobb et al., (2003) examined teachers' use of pacing guides along with other curriculum materials. The authors described the collaborations they had with some of the mathematics teachers in one school district. They discussed the teachers' practices in terms of the policies and tools provided by the school and district leaders. The pacing guides mentioned in this study were not created by the mathematics teachers themselves, but by mathematics specialists and were expected to be followed by mathematics teachers. The teachers observed and interviewed in this study initially strictly adhered to the pacing guides (and other curriculum resources). However, as the year progressed, the teachers adjusted the pace more and more when compared to the original pacing guides because they felt they needed to slow down for student understanding. This article begins to highlight some of the ideas and concepts that I propose with this study, for example how when and why mathematics teachers adjust pacing guides.

Bauml (2015) also explored how teachers use and adapt pacing guides in mathematics and science classrooms. She followed three first-year K-2 teachers through a school year to describe the advantages and disadvantages the teachers found when using prescribed materials. All three teachers graduated from the same university cohort as pre-service teachers, thus having the same pedagogical classes before entering the classroom on their own. Bauml found that these new teachers appreciated the pacing guides as a content guide, especially at the beginning of the year, and that they "strongly influenced their teaching" (p. 398). However, as the year went on, they began to express some annoyance with the pace. Bauml discussed the frustrations the teachers had with the pacing calendars, especially in mathematics, and how they felt torn between slowing down for the sake of their students' understanding and adhering the pacing calendar the administrators highly stressed. One teacher shared how she would replace time for

writing, science, and social studies in order to provide students with more time in mathematics and to keep up with the calendar. One of the other teachers shared concerns that the guide was based on higher expectations for the students developmentally than she felt appropriate. I am interested in how secondary teachers adapt pacing guides, especially considering they cannot shorten history, writing, or science time for more mathematical instruction. Bauml concluded teachers' use of the pacing guides by stating, the curriculum as represented by the "pacing calendars . . . did not allow participants enough time to help students master one concept before moving on to new concepts became so problematic that the teachers eventually chose to stray from the daily prescriptions for math" (p. 400).

The study conducted by Bauml (2015) is important in highlighting some of the benefits and disadvantages that occur with pacing guides. At times, pacing guides can be incredibly helpful to teachers, especially new teachers entering the field by providing guidance on when to teach specific skills and knowledge. However, pacing guides can also lead to frustrations among teachers when the suggested time is less than that needed to help students understand topics. This tension of the costs versus the rewards is vital when considering teachers' use of pacing guides.

Gaps in the Literature

Currently there has not been much written on pacing guides. During the literature research for this proposal only three articles written about pacing guides could be found (Bauml, 2015; Cobb et al., 2003; David, 2008). Bauml (2015) reported on a study on how teachers used pacing guides in their instruction, however, it only focused on three new teachers. There needs to be more research on more teachers, including veteran teachers who are not new to the field. Veteran teachers have a higher developed MKT, and I hypothesize, adapt their pacing guides more for their students.

As Cobb et al. (2003) noted at the end of their article, “the use of [curriculum] tools and artifacts is an underdeveloped theme in research literature on both teacher development, and policy and educational leadership” (p. 22). These authors recognized in 2003 that more research needs to be done in terms of investigating how teachers use curriculum materials. Not much has been researched in the past decade though. These three articles by Bauml (2015), Cobb et al. (2003), and David (2008) begin to investigate the role pacing guides play in the K-12 world. All three focus solely on only a few novice elementary teachers at a time. They also do not study why teachers do or do not use the pacing guides provided by the district.

How This Study Fills the Gaps

The following study examines the use of pacing guides by mathematics teachers. It includes veteran teachers along with new teachers when determining if and how much mathematics teachers use pacing guides provided by districts. It also includes secondary mathematics teachers.

Chapter III: Methodology

I begin this chapter by reviewing the purpose of the study and the initial research questions. I then move to explaining the interpretivist paradigm with which I entered the research. I continue to my research approach phenomenology, research site and participants, data collection, and methods of data analysis.

Problem of Practice

Teachers naturally adapt their teaching to the needs of the students in their classrooms. (National Academies of Sciences, Engineering, and Medicine, 2018; National Research Council, 2000, 2001; Pring et al., 2009). They make many decisions about how to best teach their lessons and what learning experiences to provide their students. Teachers must determine students' background knowledge so that instructional decisions can be made, which can then be compared to the sequence and timing of the pacing guide. Teachers also have to consider how new content and instructional materials should be presented so that it can be accessed by students (Bauml, 2015; McDuffie & Mather, 2009; National Research Council, 2000; Pring et al., 2009). All of these are curricular decisions that influence how teachers ultimately implement the pacing guide.

The problem of practice I explored with this study was what curricular reasoning teachers engaged in when they moved between the written, intended, and enacted curricula. There is a lot of material in the Virginia SOL written mathematics curriculum for teachers to teach. Teachers must decide if they will cover all of it superficially or if they will pick only some topics to teach more deeply. The purpose of this study was to examine how some mathematics teachers in Virginia make these decisions and if they use/adapt pacing guides when doing so.

Research Questions

To guide the investigation of this study, I posed the following research questions:

1. What benefits and concerns do teachers find with pacing guides?
    a. How do these benefits/concerns vary with the experience of the teacher?
2. What changes do teachers make regarding curricular pace and sequencing relative to what is stated in pacing guides given by the school districts?
    a. What are the bases for these decisions?
3. How do teachers' experiences affect their use and/or adaptation of pacing guides?

Methodology

Qualitative Approach

"Qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2011, p. 3). The purpose of this study was to explore a problem of practice in teachers' decision making of what material to teach. As Wolcott (2009) points out, qualitative researchers ask the questions, "What is going on here? What do people in this setting have to know (individually or collectively) in order to do what they are doing?" (p. 32). These are questions I hoped to answer with this study. Therefore, a qualitative approach was necessary to provide meaning to some of the decisions teachers make every day.

Paradigm

Within the qualitative design, I worked with an interpretivist paradigm. A major component of an interpretivist ontology is that there is not one reality, but multiple realities (Erickson, 1986). These multiple realities are unique to each individual and context. They are socially constructed and may change as the situations change. Therefore, the realities must be studied in context. This study attempted to define these realities through interviews and document analysis.

Interpretivist researchers have an epistemology that focuses on the reality behind the details of a situation- the motivating factors behind a person's actions (Erickson, 1986). According to an interpretivist paradigm, knowledge and meaning for an individual cannot be simply observed by a researcher. The researcher must give meaning to behaviors they see by asking questions and searching for reasons behind the observed actions (Erickson, 1986). It is important for researchers to remember that the meanings and reasoning of one person is not necessarily the same meaning and reasoning of another person. This study begins with meanings and reasoning provided by teachers. These were then layered with meanings and reasoning discovered from analysis of their actions and statements.

Interpretivist researchers assume that all methods are imperfect. Therefore, researchers under the interpretivist paradigm use multiple methods to try to triangulate their findings. This study relies heavily on interviews. However, I also asked for artifacts and any other resources teachers use when considering their curriculum pacing. The results of the teacher interviews will be triangulated with an interview with an administrator and observations I made as a participant-observer. These methods did not separate me as the researcher since I analyzed these sources and search for meaning. A researcher as instrument statement is provided below.

Research Sites and Participants

Before I accessed any sites or participants, I completed the Institution Review Board (IRB) applications for the University of Virginia. Once I received approval, I contacted the district supervisors for requesting permission to conduct research in the school district. After completing the school district applications, I then emailed mathematics teachers I know in the different sites explaining my research and asked if they would be willing to participate in this study. I also asked if they would be willing to connect me to other mathematics teachers in their

districts to expand my base.

Sites

I used two school districts for this study. The first district in Virginia, Oak County Public Schools* (OCPS), serves just under 14,000 students from preschool through grade 12. It has an area of 726 square miles, and is a combination of rural, suburban, and urban settings. OCPS is made up of 15 elementary schools (PK – grade 5), six middle schools (grades 6 – 8), four high schools (grades 9 – 12), along with eight other schools/centers specializing in everything from science and technology, to special education services, to technical education. There are 1,315 teachers employed by OCPS, 64% of whom hold advanced degrees and 2% of whom are National Board Certified. The average years of teaching experience for teachers in OCPS is 14 years. There are 97 secondary mathematics teachers in OCPS. Of the students who attend school in OCPS, just under 10% are English Learners, 29.5% are economically disadvantaged, and 12.5% are classified as students with disabilities. OCPS had an overall mathematics SOL pass rate of 81% for the 2018 – 2019 school year. Students who identified as Asian passed at a rate of 93%, Black passed a rate of 59%, Hispanic at a rate of 67%, and White at a rate of 88%. Females and males preformed at basically the same level with a pass rate of 82% and 81% respectively. Finally, those who are considered economically disadvantaged had a pass rate of 63% and students with disabilities had a pass rate of 53%.

The second Virginia district I used, Pine Grove Schools (PGS), is a small city and had 4,340 students in preschool through grade 12 as of October 2018. PGCS is made up of six elementary schools (PK – grade 4), one upper elementary school (grades 5 & 6), one middle school (grades 7 & 8), and one high school (grades 9 – 12). Of the total students in the district

* School districts have been provided a pseudonym to protect anonymity of the participants

41% of the students identify as White, 33% as Black, 12% as Hispanic/Latino, 8% as Asian/Pacific Islander/Hawaii, and 7% as other. Fourteen percent of the students in PGCS are considered Special Education Students, 14% are also ESL students, and 44% are economically disadvantaged. There are 456 teachers in PGCS, 71% of whom hold advanced degrees. The average years of experience for teachers in PGCS is 13 years. There are 20 secondary mathematics teachers in PGCS. The overall student pass rate for the mathematics SOLs in 2018 – 2019 was 72%. Asian students passed with a rate of 81%, Black students with a rate of 50%, Hispanic students with a rate of 71%, and White students with a rate of 90%. Once again, females and males has similar pass rates with 72% and 71% respectively. Finally, students who are classified as economically disadvantaged passed at a rate of 56% and students with disabilities passed at a rate of 40%.

These two different sites can offer a varied view of mathematics teaching in Virginia. The two districts provide different contexts from one another. OCPS has multiple middle and high schools whereas PGCS only has one middle and high school. I also propose these two sites because of convenience. Through my former years of teaching and my work with student teachers, I have contacts in both of these sites.

Participants

I accessed multiple mathematics teachers in both sites. The teachers provided their views and information regarding the adaptation of pacing guides in their teaching. This information was gathered through interviews and document analysis. I initially contacted teachers through email with contacts in the two sites. A summary of participants is presented below in Table 1.

I originally proposed to interview pacing guide creators and administrators as well. During my data collection though, I found that eight of the ten teachers I interviewed were also

Name	Course(s) Taught 2018-19 school year	Other Courses Taught	Total Years Taught	District	School
Ms. Cooper	8th grade math, geometry	N/A	1 year	OCPS	Johnson MS
Ms. Daniels	6th grade math (standard & academic)	2nd, 3rd, 4th, 4th-5th combo	14 years	OCPS	Jefferson MS
Ms. Crawford	AB Calculus, BC Calculus, Algebra I part 1	Algebra I, Algebra I double blocked, Algebra I part 1, Algebra I part 2, Geometry, Algebra II, Math Analysis, AB Calculus, BC Calculus, Discrete Math	27 years	OCPS	Anderson HS
Ms. Darling	Honors Geometry, Honors Trigonometry	College Algebra Trigonometry, Honors Geometry, Advanced Geometry	3 years	OCPS	Anderson HS
Mr. Castle	6th grade math (standard & honors)	All levels of 6th grade math	15 years	OCPS	Jefferson MS
Mr. Green	Geometry, AFDA/Geometry (ESOL)	Project Success Psychology, Algebra I, Algebra I part 1, Algebra I part 2, Algebra II, College Algebra and Trigonometry, Standard Geometry, Collab Standard Geometry, Advanced Geometry, Honors Geometry, Integrated Algebra/Geometry, Algebra Functions and Data Analysis	22 years	OCPS	Anderson HS
Ms. Butler	Testing coordinator	Algebra I, Algebra I part 1, Algebra I part 2, Basic Algebra, Geometry, Geometry part 1, Geometry part 2, Informal Geometry, Algebra II (regular, academic, and honors), Precalculus, AFDA, Algebra III/Trigonometry	34 (1 solely as testing coordinator)	PGCS	Carter's Creek HS
Ms. Wilson	Algebra I	SPED Algebra I, SPED Math 6	36 years	PGCS	Bakersfield MS
Mr. Richardson	Geometry, Math Analysis/Trigonometry	N/A	1 year	OCPS	Metro HS
Mr. Perry	AFDA, Geometry	SPED Algebra I, SPED Geometry, SPED AFDA, SPED Science 7	10 years	PGCS	Carter's Creek HS
Ms. Smith	Division Mathematics Coordinator	Algebra I, 7th Grade Math, 8th Grade Math, Mathematics Coach	15 years	PGCS	N/A

Table 1: Participant Summary

pacing guide writers. These participants could speak about how they use pacing guides as teachers and how they had gone about creating the pacing guides.

I also interviewed the Division Mathematics Coordinator for Pine Groves City Schools. This interview focused solely on the assertions. I asked her the degree to which she agreed and disagreed with my findings, if they were consistent with what she had seen and heard from the teachers in her district, and if it was what the administration was hoping for.

Ethical Concerns

In regard to ethical concerns, I was talking to adults over whom I have no authority. I explained the purpose of my research and gave them the option to end the interview at any time if they chose to do so. I also used pseudonyms for school districts and teachers to keep names confidential. This research does not have any influence on their job security. It was simply to understand how and why teachers make the decisions they do in reference to pacing guides.

Data Collection

I followed a phenomenological method of research. The purpose of a phenomenological study is to describe and understand the phenomenon being studied from the participants' perspectives (Kvale & Brinkmann, 2009). "A researcher applying phenomenology is concerned with the lived experiences of people . . . involved, or who were involved, with the issue that is being researched" (Groenewald, 2004, p. 44). This study hoped to understand how and why teachers adapt instructional pace and/or sequencing of topics in the ways they do. I used teachers' "own perspectives to provide insight into their motivations" (Groenewald, 2004, p. 45).

Interviews

Interpretivism and phenomenology rely heavily on participants' own meanings and reasonings. Both mindsets believe and advocate that knowledge cannot be isolated from people

and researchers cannot be separated from their research participants. The goal of phenomenology is to understand what is occurring and why it is occurring with each individual person, therefore findings are not permanent or universal. The findings from one study are relative to that specific time, place, and context. Phenomenological and interpretivist researchers interact with their participants in their own surroundings conducting interviews and collecting data (Erickson, 1986; Groenewald, 2004; Kvale & Brinkmann, 2009).

As stated earlier, interviews were the main source of data for this study. Interviews provided the potential for gaining access to and describing teachers' curricular reasoning and every day decisions (Kvale & Brinkmann, 2009). I began each interview with a brief statement to introduce the purpose of my study and provided the participants an opportunity to ask any questions they might have (Kvale, 2007). I followed a semi-structured interview with teachers (Included in appendix A). This type of interview "seeks to obtain descriptions of the interviewees' lived world with respect to interpretation of the meaning of the described phenomena" (Kvale & Brinkmann, 2009, p. 27). I initially conducted one interview with each teacher, ranging 30 minutes to an hour in length. I took some notes during these interviews and audio recorded all interviews. These notes were used to guide the interview and ask follow up questions later in the interview and occasionally after the interview. The interview followed the semi-structured protocol provided. Five of them required follow-up interviews conducted via email for more detail and clarification. All interviews were conducted in Spring and Summer, 2019.

Documents and Artifacts

I also asked teachers for any calendars/pacing guides they created for themselves and/or team members. These were used to look at the degree to which these artifacts differ from the

pacing guides provided by the district. In particular, I was interested in asking teachers for any artifacts that may affect their planning and teaching as well. I provided teachers with a copy of the pacing guide for their course. I asked the teachers to choose a section or unit and describe what changes, if any, they made when teaching the material to their students. I anticipated that veteran teachers have created their own calendars using their experience of working with students.

Participant Observations

I worked with the district mathematics coordinator, mathematics specialists, and elementary teachers during the Summer of 2017 creating mathematics pacing guides. During this time I took notes as a participant observer. I focused on the interactions between and among the teachers, specialists, and coordinator when writing pacing guides for the following school year. These observations helped triangulate my findings from this study.

Researcher Role

Consistent with my interpretivist approach to qualitative research, I believed in the need for self-reflection by the researcher. Therefore, it is necessary to address how I was the primary data-collecting instrument for this study and my background. I earned a Bachelor's of Science in Mathematics and a Master's in Education before I began teaching full time (I was a long-term substitute teacher while working on my Master's degree). I taught high school mathematics for three years in Northern Virginia. This included courses from Algebra I through AP Calculus AB. I recognize that I have a bias against pacing guides. While I was teaching, I did not find them helpful in assisting my students reach their fullest potential in mathematics. I felt as though the curriculum, as reflected by the pacing guides my district provided expected students to be farther along in learning mathematics than they were. Some of my students were new to the country,

state, and/or county, while others had grown up in the same school district. It did not seem to matter if they had moved into the district or not, though. I often had to go back and teach pertinent missing and/or forgotten mathematical topics. I also had to slow down in my pace to provide students opportunities to work with and conceptualize a topic. My colleagues and I were consistently trying to find strategies that helped the students connect with and make sense of the material while also filling in gaps of missing information. The rest of the mathematics department and I did not make any changes to the sequencing of topics as suggested in the pacing guide. After leaving teaching and beginning my studies again, I became a University Supervisor/Coach for pre-service teachers in both primary education and secondary education. I have supervised/coached pre-service teachers in elementary, history, science, and mathematics education. I have worked most closely with the secondary math pre-service teachers over the past four years as they work in classrooms and reflect on their experiences.

While conducting this study, I constantly made efforts to limit the biases of my experiences with pacing guides. I strived to have an accurate portrayal of teachers' views and uses of curriculum guides and the curricular reasoning that occurs. To do this, I used methods of reflexivity by keeping a methodology log and writing memos based on my findings from data collection. I had a peer reviewer, who is also familiar with teaching secondary mathematics in Virginia. She and I discussed my findings on a regular basis, reviewed my approach, and ultimately my findings. I also consistently debriefed with my advisor about what my research was uncovering. I shared the data from the interviews and artifact collection with him in order to limit my prejudices against pacing guides.

Researcher as Instrument

I was the only researcher working on this study; therefore, I talked with all of the

participants. This means that I did not have to worry about inter-rater reliability. Because of my preexisting experiences in the proposed sites, I knew all of the individuals participating in this study. I made it clear about the purpose of my study to all of those involved. I was also the one interpreting their statements and artifacts. I provided meaning to the data collected and searching for trends.

Analyzing the Data

Following the advice from Erickson (1986), I used an inductive approach to coding data. I searched for patterns using line-by-line coding of the data and following my conceptual framework presented in the previous chapter. I consistently compared my new data with previously collected data (Corbin & Strauss, 2008). This provided opportunities to expand my collection of patterns and will decrease the impact of my biases.

I transcribed all my notes from my interviews. I used Dedoose software as a tool for coding and searching for patterns. I then created analytic memos after each interview and observation. Any patterns and assertions that initially appeared from the interviews and observations provided focus for continued data analysis. I also kept a reflective log after each data collection and analyzing opportunity. These logs tracked my biases, decisions, and actions. My assertions were based on any patterns I found.

All assertions were backed by evidentiary warrants. Any assertions I found were kept track in analytic memos and my methodological journal, as described in Erickson (1986). I then continued to search for confirming and disconfirming evidence (Erickson, 1986) through analytic induction, and continued to revise my assertions to match all the data I collected. I participated in member-checking where participants were provided with assertions in order to confirm or disconfirm my assertions.

The assertions were compared with observations I made as a participant-observer during the Summer of 2017. I worked with the district mathematics coordinator and elementary teachers for five days, six hours each day, during the summer. The teachers, district mathematics coordinator, and I worked together to create new pacing guides for kindergarten through fourth grade. Observations I made during this curriculum work week were aligned with what I found during this study, and will be discussed more in chapter five.

I also reviewed all assertions and supplementing evidence with my peer reviewer and advisor to try to limit my biases. My peer reviewer is also a former Virginia high school mathematics teacher and a doctoral student at the University of Virginia. This review process was done in a two-phase process. After each assertion was drafted, I sent it to my peer reviewer. She read them one at a time, and provided feedback on the wording of the assertions in order for them to fit the data. I used her feedback to revise my assertions to better represent the evidence I collected, which were then sent to my advisor for feedback as well. He also looked at the assertions and supporting evidence. We discussed the assertions and evidence to review the wording of assertions in order to accurately reflect the evidence. He and I met after each draft to discuss the conclusions.

Phenomenology is not meant to find generalizations which can apply to the greater population. Instead the purpose is to describe the participants' views of events as they occur. Therefore, I use rich descriptions to provide others the opportunity to understand the teachers' reasonings for adjusting the pacing guides.

Chapter IV: Findings

The purpose of this study is to examine some mathematics teachers' perceptions of common pacing guides. I also examined how these teachers adapt provided pacing guides and what curricular reasoning processes these teachers go through to make adjustments. I spoke with both veteran mathematics teachers and novice teachers to try to understand the reasoning behind the teachers' curricular decisions.

Through semi-structured interviews, I attempted to answer the following research questions:

1. What benefits and concerns do teachers find with pacing guides?
    a. How do these benefits/concerns vary with the experience of the teacher?
2. What changes do teachers make regarding curricular pacing and sequencing relative to what is stated in pacing guides given by the school districts?
    a. What are the basis for these changes?
3. How does teacher experience affect their use and/or adaptation of pacing guides?

I interviewed ten mathematics teachers in Pine Grove City Schools and Oak County Public Schools. The summary of the participants is presented in the previous chapter in Table 1 on page 45. These teachers ranged from first year teachers to teachers with more than 30 years of teaching. Some had many years of experience teaching mathematics, while others had experience as well. They provided a range of viewpoints and examples when sharing their thoughts and opinions on pacing guides.

These were common themes that emerged during the interviews with the mathematics teachers. These assertions touch on the teachers' thoughts and feelings on common pacing

guides, their movements between the written and enacted curriculum, and how their experience affects their adaptations to pacing guides, review, and common assessments.

Assertion 1

Assertion: Mathematics teachers in Oak County Public Schools and Pine Grove City Schools believe common pacing guides are beneficial for at least one of three reasons. Following pacing guides can: (1) keep all teachers at close to same pace across the schools; (2) help new teachers plan; and/or (3) provide accountability to the written curriculum.

Keeping Teachers on the Same Pace

One recurring expressed benefit of common pacing guides provided by mathematics teachers in Oak County Public Schools and Pine Grove City Schools was their belief that referring to common pacing guides can keep teachers at relatively the same pace. This is important to them because any students who move between schools during the school year will not lose much ground.

Ms. Crawford, a veteran mathematics teacher of 27 years, has experienced previous years of common pacing guides in Oak County Public Schools. However, in the past decade, the district has let that commonality fall away. Ms. Crawford though believes that this was a mistake:

> "[T]hat common thought of we all have to be on the same page just got lost by the way side and we didn't have any [district] leadership. Since that time in the last two or three years we've just we've figured out, I mean the hard way, that you have to have some [commonality] … I've been saying for years we had to have it. So finally, we have some division wide leadership that's supporting that. So, it's actually a good thing. It's been a hard change because that means everybody is doing the same approximate order but that's good because we have, we have transient kids [that move during the year]" (C. Crawford, Interview, May, 14, 2019).

Ms. Crawford is excited that Oak County Public Schools is beginning to move back towards having a common pacing guide for all core subject areas. According to her, the teachers at Anderson High School have been looking forward to common pacing guides and common assessments that they know other teachers in the school district are likely to be using. In fact, the teachers at Anderson High School took the lead on creating a suggested common pacing guide for *Geometry* and *Algebra II*. This would allow the teachers to be able to compare assessment data more accurately and help students who do switch schools during the school year.

Ms. Daniels, a middle school mathematics teacher in Oak County Public Schools, also referred to the students who change schools during the school year, when discussing the benefits of a common pacing guide:

> "I do think it would be beneficial for kids because we have a lot of transient kids. And it sucks when they come from another school and they've learned everything that you're planning on teaching for the rest of the year, but have no concept of fractions, decimals, and percents. 'Cause they were going to teach it in second quarter or third quarter and you've already taught it and that's like a whole month-long unit that what are they going, you know? So, I do think for that it would be helpful" (B. Daniels, Interview, May, 30, 2019).

Ms. Daniels shared that she and her *Sixth-grade Mathematics* team decided to put the unit on fractions, decimal, and percents at the end of the first quarter because it is so vital to future learning. She also said they are unlikely to have disruptions to the school calendar at the end of the first quarter, unlike during the winter months of second and third quarter. This example of curricular reasoning had a major impact on the sequencing present in the pacing guide from Jefferson Middle School.

Ms. Daniels did not have much knowledge about Oak County Public Schools beginning to push the creation of a common pacing guides across the district, yet she was open to the idea. She and her colleagues on the *Sixth-grade Mathematics* team at Jefferson Middle School collaborate at least twice a week and share resources to create their own pacing guide. Ms. Daniels said she would be willing to collaborate with other middle school teachers in the district to do the same. Ms. Daniels is more than happy to share the pacing guide from Jefferson Middle School, but would want to discuss any changes with other teachers.

I believe keeping teachers on the exact same pace is impossible. However, providing a pacing *guide* in order to help teachers understand they cannot spend too much amount of time on one topic is useful. By keeping it a *guide*, teachers are able to adapt the pace to their students. As Ms. Cooper said, "There should be [common pacing guides] … I think as long as there isn't a lot of pressure from the county to follow it to the letter, I think it would be really helpful" (A. Cooper, Interview, May, 31, 2019).

Help New Teachers

The two first-year mathematics teachers with whom I spoke, Ms. Cooper and Mr. Richardson, both expressed a desire for a more detailed pacing guide from their school and/or their county, Oak County Public Schools. This is similar to findings from other studies such as Bauml (2015).

Ms. Cooper, who taught *Eighth-grade Mathematics* and *Geometry*, was provided a pacing guide from a veteran teacher for the *Eighth-grade Mathematics* course. However, she was the only *Geometry* teacher at her Johnson Middle School, so she did not have a pacing guide for that course. Ms. Cooper was able use knowledge gained from her student teaching experience in order to create her sequencing of topics. When asked about a common pacing guide across Oak

County Public Schools she said, “Especially as a first year teacher just to see like when we talk about Geometry, I was just like clueless and I think that would be like very helpful to just see like just a general sense that you could like adjust to fit your kids” (A. Cooper, Interview, May, 31, 2019).

Mr. Richardson taught *Geometry* and *Math Analysis/Trigonometry* at Metro High School, which is also located in Oak County Public Schools. For the *Math Analysis/Trigonometry* course, Mr. Richardson was provided a calendar of topics by a teacher who had taught the course previously. He was also given a calendar by another teacher, grouping topics for *Geometry* by months. However, Mr. Richardson would have liked more detail and assistance, even going as far as possible lesson plans, especially for his first year of teaching:

> “Coming in brand new, I had no idea how much time to spend on things. Like should I present one lesson on something? … So having some information was good on a broad scale. Where I felt I struggled with was coming up with the day to day stuff. Like if you did … know that this [group] of topics is chunked in this amount of time, how much should you put in one lesson? How much can you put in four lessons? How, when, how often do you assess what's a good means or frequency of assessment? All of those, that I consider more fine detail stuff was just totally left up to me” (S. Richardson, Interview, June 4, 2019).

Ms. Butler, a 34-year veteran mathematics teacher of Pine Grove City Schools, also spoke to the benefits of having a pacing guide to follow during the first year(s) teaching a course:

> “I would say when I first started teaching a course, I used the pacing guide to kind of have a sense of it. But often what I would do is kind of like, particularly after like three or four years when I kind of started to have a feeling about how things would go, I would

> start to use the pacing guide. And then I would also, I looked at the pacing guide more for sequence than I did for timing. And so, I would kind of plot it out myself and then kind of compare to the pacing guide" (L. Butler, Interview, June, 7, 2019).

Even after years of teaching mathematics, when Ms. Butler was assigned to teach a new course, such as teaching *Algebra II* in addition to or instead of *Algebra I*, during her first couple of years she relied on the pacing guide for the new course to influence the sequencing and timing of her instruction. Ms. Butler was not the only one to speak about relying heavily on a pacing guide when switching the courses she taught, Mr. Green had similar feelings. He explained that he would ask teachers who had previously taught the course(s) for any pacing guides and advice.

The mathematics teachers new to the profession with whom I spoke shared that pacing guides in general and/or more detailed pacing guides would have made their first-year teaching significantly easier in terms of planning. Other veteran mathematics teachers, including Ms. Butler and Mr. Green, also shared that they found pacing guides useful even after they had been teaching for a few years, specifically when they were assigned to teach a new course. Not only do pacing guides provide advice to teachers on sequencing of topics and the amount of time to spend on each topic, but they also keep teachers accountable to teaching the standards set out by the VDOE.

I believe these new teachers wanted more details for a variety of reasons. These teachers have not had much experience in the classroom, especially outside of their student teaching experience. Therefore, they have not had the opportunity to develop much MKT for themselves. Because they have not had much experience themselves, they may not have much confidence in themselves and their decisions. These novice teachers have also probably not seen examples of pacing guides in their teacher education programs.

Provide "Accountability"

Another benefit of common pacing guides is that they provide frameworks to hold teachers accountable to teach all of the specified topics in the written curriculum. Mr. Castle expressed his thoughts when he said,

> "I think [common pacing guides] could be a good thing because it holds teachers accountable. And then it makes sure that teachers aren't just doing their own thing and that you're getting the curriculum in and you're getting things done like it's supposed to be done. So, for example, somebody is teaching some concept but they're not doing it to the specifics that, you know, the county or the state is looking for, and those students are not going to do well on that concept come SOL time. And everyone says SOL scores don't matter, but they do matter. Especially when you're not hitting those marks. So, you need to see where people are and make sure that the content is getting covered" (J. Castle, Interview, June 3, 2019).

Mr. Castle and fellow *Sixth-grade Mathematics* teachers at Jefferson Middle School in Oak County Public Schools have worked hard to create a pacing guide they all agree on and follow. It is not a requirement of the school or county administration that the *Sixth-grade Mathematics* teachers followed the same sequence or pace. However, Mr. Castle, Ms. Daniels, and their third team member have found that the students do better when they work together as a team. In fact, they were called "miracle workers" after the 2018-2019 school year because of the progress the sixth-grade students made. Ms. Daniels said, "What I've found is that, you find success on your own because you have control of everything as long as you're successfully working in the right path. But you can find even more success when you do have other people. … I think kids find more success in general when there is more than one person collaborating because you always

have a second opinion" (B. Daniels, Interview, May 30, 2019). This team collaboration has found success over the years of sharing ideas and holding one another accountable.

Ms. Daniels also spoke to curriculum accountability provided by pacing guides:

> "So, in some sense I think [common pacing guides] takes away a lot of autonomy [from] teachers … However, I think our county specifically is extremely weak in certain areas of instruction and accountability. And I think what they're trying to do is specifically with the new superintendent is try and beef up the accountability by increasing the number of common assessments. And you can't have common assessments across all the schools if you don't have common pacing. Because then you're not comparing the data [accurately]" (B. Daniels, Interview, May 30, 2019).

Ms. Daniels and Mr. Castle seem to feel that not all teachers are held accountable to get through the curriculum in Oak County Public Schools. They have been working hard at Jefferson Middle School to hold one another accountable for teaching the required and necessary mathematics standards. It seemed to me when interviewing both Ms. Daniels and Mr. Castle that they felt everyone should be held to the same level.

The issue of accountability was also present when talking to teachers from Pine Grove City Schools. For example, in her interview Ms. Wilson said,

> "I like pacing guides. When I started teaching, they weren't a big thing and, but I like them because it really does lay out the year and I am able to lay out the year for the students so that they know that this is what we're going to be doing…. Cause it really does kind of keep you on track so you don't get behind. … And I guess [a pacing guide] really does keep you focused towards a goal" (L. Wilson, Interview, June 12, 2019).

This veteran mathematics teacher knows what she is expected to teach and after 36 years where students are likely to have trouble with the material. Yet, she mentioned that she uses the pacing guides as a way to keep herself from getting off track and to try to make sure she fits in all the material before the end of year exam. She and her *Algebra I* colleagues at Bakersfield Middle School expect one another to stay at a similar pace as one another and teach all the material in the written curriculum.

The teachers I spoke to in both Oak County Public Schools and Pine Grove City Schools all believed that common pacing guides could be very useful for at least one of the three reasons mentioned above. Some of these teachers were even a part of creating the pacing guides for their school district. It is important to note though, as Ms. Cooper did, that these documents should be viewed as guides for mathematics teachers. I believe, the teachers have to feel as though the administration has confidence in them as teachers to adapt the suggest pace and/or sequencing to the students in their class.

Assertion 2

Assertion: Because there were so many topics in the written curriculum to cover mathematics teachers took at least one of two actions: (1) they restricted their teaching by either eliminating the teaching of applications or not going into deeper explorations of topics; and/or (2) they cut out material in order to spend more time on topics they deemed more important because the "important" topics were foundational for subsequent mathematics classes and/or on the SOL end of year exams.

Teachers have a certain amount of material they are expected to expose students to as dictated by the written curriculum. However, most teachers also want to encourage students to continue to explore mathematics, see applications of mathematical topics, and find areas of interest and relevance. But, because of the exams, and the pacing guides based on them, teachers sometimes have difficulty in fitting in these explorations and demonstrations of how mathematics topics can be used outside of the classroom into the school year. This restriction was because teachers were trying to get through all the topics that would be on the SOL exams. Mr. Green, a mathematics teacher at Anderson High School, shared,

> "I think quite often because the test simply due to the timeframe when it comes, it comes not at the end of the year, and the amount of material that you know, Geometry has to cover as well as also Algebra II. Both those content areas feel the crunch of getting through the material, too massive amount, and we have to go through" (J. Green, Interview, May 7, 2019).

Mr. Green has taught high school mathematics for over two decades. He knows the content and the expectations of him. However, he also feels the "crunch of getting through the material in time for the exam. Because of this "crunch", teachers found themselves having to choose when,

or if, to teach applications of mathematics, when to allow student to have deeper exploration with mathematics, and which topics would not be taught at all. This occurred when teachers were spending more time on topics they believed were more important for students to learn.

Restricting Teaching

Ms. Darling shared her experience of teaching *Geometry* at Anderson High School during the 2018-2019 school year:

> "We even cut out anything extra, anything over the top. We just went straight back to here are the basics, here's how you do it, here's some practice. We've got to keep moving. And so, we even cut out like so many things I would probably would have done with circles- of Pythagorean theorem on tangents, and things, and whatever. I did like one and then I kept moving because they weren't going to remember the chord rules as it was, yet alone if you see a triangle inside the thing, you have to use Pythagorean theorem to solve … I just was like, that's going to unnecessarily confuse them when they're already confused as it is. So, we cut it down to bare minimum, teach the stray topics, do some practice … And then otherwise, it was just so, we cut out application problems. For the sake of just here focus on the rules, here's how you're going to do it, with the hopes that if they like sat down at the SOL and they saw a problem and had 15 million words on it, maybe they would get out of it one is a tangent, one is a secant. Here's what I was supposed to do" (C. Darling, Interview, May 20, 2019).

Ms. Darling was very frustrated when she shared this information. She wanted to include the application examples and assist students in seeing the connections between topics. Yet, there was not enough time for her to fit everything in. She had to decide what to cut and what "basics" the

students still needed to learn. Ms. Darling used her specialized content knowledge and knowledge of content and students to determine what the basics were.

Ms. Butler also expressed frustration with the standards and exams. She has been teaching for 34 years, and therefore has been in Pine Grove City Schools before the SOL exams were first introduced. She said, "[I have been here] [l]ong enough to have not had them and I hate them. Because I feel like they're too restrictive. Like that we're going to test on all these little different topics makes it hard for teachers, myself included, to feel like you can explore, you know, like when something comes up in class" (L. Butler, Interview, June 7, 2019). One prime example of when Ms. Butler had to stop student exploration and questions was in her *Algebra II* class. She and her students were discussing vertical and horizontal asymptotes, and how the graphs change based on the degree of the polynomial. A student then asked her, "Can they have a parabolic asymptote?" Ms. Butler commented about this exchange,

> "Well with SOLs sitting out here, it's very hard to, say take class time to then explore that concept because that concept [is] not on the SOL test. … The fact that there's a test that measures specific things and that it's so long and laborious and that to me I don't like, because I feel like that that does to kids exactly what we don't want to do to them as far as math is concerned and make it a set of facts and procedures. I want them to be curious about it. What happens if this happens? What happens if that, you know, because that honestly, that's where I fell in love with it. And the kids still think it's funny if I come across something and I'll go, 'oh wow. Did you notice that?' You know, like that whole noticing and being curious about it is what I want them to get. And that doesn't happen when you're restricted to the time and topics" (L. Butler, Interview, June 7, 2019).

Ms. Butler felt as though the SOL end of year exam impeded her ability to follow students' leads and questions about mathematics. She was able to use her teaching skills and years of experience to fit in some additional material though:

> "I kind of added stuff in, you know. Like we did problems of the week that were put out by the math forum for several years and a couple of, about three years ago, three or four years ago, we actually did a mentoring project with students down in Trinidad, but I kind of weaved that in, so the focus was still on what skills they would need to pass the test … So, I really had to be creative though about how I taught. Like if there was something I wanted to do to pique their interest, how can I fit that in? Like where can I put it? And so that it will relate to the topic that we're doing so that we're building on stuff" (L. Butler, Interview, June 7, 2019).

Ms. Butler wanted to answer students' questions and find ways of letting them explore mathematics. However, she had to be incredibly "creative" to find ways of working the explorations in. She knew she had to prepare students for the SOL exams and thus did not get to do as much exploration as she originally wanted. Ms. Butler used her specialized content knowledge, knowledge of content and teaching, and knowledge of content and students in order to work in explorations with her students.

Mr. Green also shared that he would have to restrict students' explorations with two topics in *Geometry*:

> "The two units I should say that get really compacted are circles, which unfortunately, 'cause there's a lot of stuff in circles to do. And then also constructions and stuff. So, yeah, you lose a lot of deep dive with that, which is, in my opinion, some of the coolest stuff in geometry" (J. Green, Interview, May 7, 2019).

Mr. Green would like to do a more in-depth study with his students on circles and constructions. However, because of the pressure of the SOL exam, he could not give the students the time to investigate these topics further.

Cut from the Written Curriculum

Mr. Green indicated that he felt similarly as Ms. Butler and other teachers. He specifically brought up the question that drives many of the decisions teachers make, "The ultimate driving question that we actually ask administrators and we ask ourselves all the time is, you know, do you at the end of the day, should you teach all of the material or teach a percentage of it very well. You know, that's, that's sort of the question that's up for debate" (J. Green, Interview, May 7, 2019). Most teachers would agree that it teaching all the material very well is the best option. However, as Mr. Green alluded to in the quote at the beginning of this assertion, there is simply not enough time in the school year and/or too much material in the written curriculum in order to do so. These *Geometry* and *Algebra II* teachers that Mr. Green refers to, have to make a decision about what to spend time on and "teach very well." When making the choices, the teachers may find themselves without enough time to teach all of the topics in the written curriculum, and thus have to cut some material.

Mr. Richardson found that he had too much to teach at the end of the school year, and thus decided to cut material, for example constructions, from the written curriculum when converting it to his enacted curriculum.

> "There were certain things I cut from Geometry. … Part of it had to do with keeping up on the quarterly pace. … We basically use[d] the end of the quarter as a check in to, 'okay, here's where we're at, time to move on to the next thing.' And so, if there were one or two things I hadn't covered, I sort of crossed my fingers and hope I'd have time to

> review it at the end of the year before the SOL. Which didn't happen. There were a couple, again, weird schedule days, you know, like sophomore field trip or something, which would just remove a random day of instruction out of the week that wasn't really expected. And that kind of meant I had to drop some things, and given my Geometry class', I guess fundamental strengths and mathematical experience, it was sometimes a tough call on whether to continue with a certain topic that they weren't quite grasping or just cutting the losses and moving on. So certain things I kind of played by ear and made guesses on how much time I would spend on a certain topic. And in doing that and making all those decisions to extend time or stretch time, it ended up just leaving some time or just running out of time" (S. Richardson, Interview, June 4, 2019).

Mr. Richardson's decisions left his students without instruction on certain material in the written curriculum. He, like Mr. Green, though, felt it was more important that students spend more time on earlier topics and understand the material more fully. This was both foundational material and topics Mr. Richardson thought would be represented by more questions on the SOL end of year exam. An example of the pacing guide provided to Mr. Richardson by his school district is in Appendix B.

When Ms. Butler found herself behind in terms of pace, she would consider which topics she wanted to spend her class time:

> "Honestly, I just try to take a breath and go, 'Okay, what's most important here and where do we go?' And if the kids are struggling over something that I feel like is not super valuable, even if it's an SOL item, I'll say, 'No, we're going to forget that.' You know, you just have to give up some things to get the things that are more meaningful and more

> valuable… they need for another class or that connects to something and will help them then connect to some new, other concepts" (L. Butler, Interview, June 7, 2019).

Ms. Butler said she would think about what students needed to know to succeed in future mathematics classes along with on the SOL exam. She would then spend her instructional time on those topics. Ms. Butler used her horizon content knowledge to make these decisions.

Assertion 3

Assertion: Experienced teachers adjust school or district pacing guides based on their own experience teaching the content and working with students. These adjusted pacing guides are deemed by the teacher as more appropriate than the given ones for approximating the amount of time they expect to spend on each topic. Novice teachers, on the other hand, relied on either the given pacing guides or the ones adjusted by their more experienced colleagues.

When talking to Mr. Green, a veteran mathematics teacher of 22 years, he shared his process when planning for an upcoming school year:

> "It's actually kind of the thought process that goes into it. … I definitely reflect and say, 'Okay, you know, this past year students really seem to struggle with biconditional statements. So maybe instead of one day, let's kind of use two days.' And then, so what I'll do is if I'm borrowing a day here, where can I tweak and see typically the students seem pretty strong with this" (J. Green, Interview, May 7, 2019).

Mr. Green tries to consider where students have typically had difficulty from the previous year. Then, because there is a limited amount of time in the school year and many topics in the written curriculum, Mr. Green had to adjust time spent on other topics. This was his process of considering past years of teaching when planning for a new school year of that same topics, for example *Geometry*. However, there were times he had to plan his expected pace for a topic he had not had experience teaching. When this occurred, he would still use experience of students' strengths, but that of other teachers:

> "Towards the end of the year, I try to definitely get with teachers who are veterans of that subject and say, 'Hey, you know, where do you see typical issues?' And it's funny, teaching math is, … there's definitely common themes. Anything with an f word-

> fractions, factoring, you know, you definitely have to spend time on that… Yeah, so I tap into my prior knowledge and definitely my colleagues around me is a big, big resource" (J. Green, Interview, May 7, 2019).

Mr. Green values his colleagues' and his experience when planning future school years.

Ms. Wilson, who has had 36 years' experience teaching, also touched on how she and her colleagues use past experience of working with students to determine pacing for upcoming school years:

> "[The amount of time to spend on each topic] was basically a discussion from the experience that we've had over the years on how much more work students needed, how much more practice time. Just talking about that and making adjustments that way, based on what we had observed over the years" (L. Wilson, Interview, June 12, 2019).

Ms. Wilson and her fellow *Algebra I* teachers adjust their pacing guide every year depending on what they have noticed when working with students.

Ms. Daniels firmly believes that teachers' experience leads to strong pacing guides.

> "I don't think you can really truly make a solid pacing guide until you've actually taught a year with the content to know what really will actually happen. … I think [the knowledge gained from years of teaching] helps create a better pacing guide" (B. Daniels, Interview, May 30, 2019).

Ms. Daniels' coworker, Mr. Castle had similar feeling. He said, "You find out, wow. Like these fractions take longer than this week that we've allotted for. So, we make that adjustment" (J. Castle, Interview, June 3, 2019). These mathematics teachers believe that the best pacing guides are created after at least one year of working with students and the content. They would use the

knowledge gained from years of teaching (Ms. Daniels - 14 years, Mr. Castle - 15 years) to decide on what they believed was the best pacing and sequencing for their students.

The two first-year mathematics teachers I spoke with used their colleagues' experience as a major resource when planning for the school year. For example, Ms. Cooper trusted the veteran teacher of her eighth-grade mathematics planning team:

> "So, there are four of us in [the mathematics eight] PLC - me, another first year teacher, a special ed teacher, and then a veteran teacher of 25 years. And she basically made the pacing guide and then asked us, 'how does this sound?' And we were like, 'Yup, sounds good.' And that was about what it was" (A. Cooper, Interview, May 31, 2019).

Ms. Cooper shared that she may have paced her classes differently, faster in some areas if she was not following her colleagues' lead. However, she trusted her colleague's thoughts and experience from more than two decades of teaching. When reflecting about the 2018-2019 school year, Mr. Richardson, another first year teacher, could already see that his one year of experience would affect his future teaching. He said, "I can see myself now that I know, even with one year down, I kind of have a better understanding of what the content is exactly" (S. Richardson, Interview, June 4, 2019).

Ms. Butler also reflected on her first years of teaching a course:

> "I would say when I first started teaching a course, I used the pacing guide to kind of have a sense of it. But often what I would do is kind of, particularly after like three or four years when I kind of started to have a feeling about how things would go, I would … look at the pacing guide more for sequence than I did for timing. And so, I would kind of plot it out myself and then kind of compare to the pacing guide" (L. Butler, Interview, June 7, 2019).

Ms. Butler has had more than thirty years of teaching high school mathematics in Pine Grove City Schools. She remembers using the pacing guide when teaching a course for the first time, but then adapting it, especially in terms of pace, after a few years of teaching. She used her experience with students and content to make a pacing guide she believed would lead to the greatest success for her students.

Assertion 4

Assertion: All teachers tried to include time in their courses to review foundational topics and/or topics that would be included on the exam.

All the mathematics teachers I spoke to in Pine Grove City Schools and Oak County Public Schools mentioned the decisions they made about when and where to insert review time. These teachers reasoned that there were important times and places during the school year for review. These reviews were sometimes of material students were expected to have learned in previous classes. Just about every teacher also brought up specific review time for the SOL end of year exam. In some pacing guides given to teachers from the districts, SOL exam review time would be included, but not all of them. Pacing guides created by teachers almost always had this time worked in. However, there was no mention of review of foundational information in any pacing guides.

Foundational Material

Ms. Cooper shared that she was off pace with her *Eighth-grade Mathematics* students very early on in the year. This is because she, and all the other teachers on her team, found that they had to go back to review/reteach topics students did not learn in earlier grades:

> "We very quickly got off the pace. By like, three or four weeks, very much off pace. Yeah. And then by the beginning of the second nine weeks, we were off by maybe two weeks and by the beginning of the third we were off by maybe three or four. … So we started doing number and number sense, like compare and order, real numbers. And we noticed that it was just a huge gap with even knowing what real numbers are. So, we added in a maybe two-week unit on just like adding and subtracting fractions, just like

> basic, like math, computation skills and that pushed everything off pretty quick" (A. Cooper, Interview, May 31, 2016)

Because Ms. Cooper and her fellow *Eighth-grade Mathematics* teachers had to go back to review/reteach a unit on adding/subtracting fractions and other basic computation skills, they had difficulty at the end of the school year making it through all the material in the written curriculum, as discussed above. However, they felt as though this review time was necessary for the students to be successful with new material.

Ms. Crawford also explained how she spends the first few weeks of school working with her *Algebra I Part I* students:

> "I mean you know these are your most struggling kids you know. Just I mean like we spent three or four weeks in the beginning of the year doing classroom norms and basically learning how to solve a one-step equation - which they should have known in sixth or seventh grade. So, some of it is just reteaching what they already learned and just getting them confident and being in high school" (C. Crawford, Interview, May 14, 2019).

Ms. Crawford and her collaboration teacher for *Algebra I Part I* want these students to find success and confidence in the beginning of their high school mathematics careers. Therefore, they value the extra time spent on reviewing/reteaching material the students were expected to learn two or three years prior to entering their classroom.

Ms. Darling expressed frustration with the pacing guide she was provided by her school during the 2018-2019 school year. Because the pacing guide did not have any time for teachers to review material from previous mathematics classes, Ms Darling found herself behind from day one:

> "I ended up spending like three weeks alone on reviewing Algebra I before I even was able to get to like parallel, perpendicular, symmetry, transformations, like any of that stuff, which then essentially meant I took this all the way up through, well I took logic all the way up through I think the end of the first quarter. And then triangles actually took us through the whole second quarter into the third quarter. … And the idea that like this [common pacing guide] is great if everybody knows everything and you don't have to like stop, which to be quite freaking honest, my children don't understand anything the first time" (C. Darling, Interview, May 20, 2019).

Ms. Darling felt like she was playing catch-up from the beginning of the school year in her *Algebra II* course because she had review/reteach material students did not learn well in *Algebra I.* The pacing guide provided to Ms. Darling by her administrator (a former mathematics teacher) did not account for this time or the time Ms. Darling needed to help students understand the material.

Mr. Green specifically planned this time of review and/or reteaching into their introduction of a new topic:

> "So, teaching like Algebra II, when I've taught it in the past, when we get into rational expressions, I will literally place fractions, no variables whatsoever, fractions. So, we just kind of ask questions, 'Okay, what do you do? Why do you do it?' All of that stuff to make sure they're sound with this to make the transition into rational expressions much more tangible. One of the things, again, this is a conversation we're having with middle school and also elementary school is long division. They are now teaching so many different methods. So, when we show polynomial division, the relationship back to, 'hey, do you remember doing problems like these?' Well some students raise their hand and

> have never seen that before. Yeah, we have to go back and teach division by hand and stuff before we get into polynomial division" (J. Green, Interview, May 7, 2019).

Using his experience as a guide, Mr. Green knew he had to work review time into his pacing. He did not seem frustrated by the additional review. He simply saw it as necessary and a way to help his students find more success in *Algebra II*.

Other teachers had policies that helped them stay with the pace of the pacing guide. For example, Ms. Daniels and Mr. Castle's math team had the policy that all classroom instruction must be at least on grade level - addressing the topics in the written curriculum.

> "All work will be on grade level. Like all instruction will be on grade level. If a kid needs time to learn long division, multiplication, something like that, then it has to be, it can be like 15 minutes of class. But then other than that you have to push them farther. So, the expectation is set really high. So even for our standard kids. When we get to those places where we're like, 'God, they're really struggling. Like what do we do?' We still have to give this quiz? We'll try and find ways to kind of like add it, add in something specific into a homework, so that it might cycle a little bit more. Or we might try and find a way to pull them during home room and work with them during home room on a specific skill. But we still push through" (B. Daniels, Interview, May 30, 2019).

Exam Review Time

The teachers with whom I spoke also mentioned that they built in at least a week of review specific to the SOL end of year exam, or they tried to. This review was of material in the written curriculum for the courses they were teaching, as opposed to prior mathematics courses. The reviews were specifically for trying to help students do well on the exam. Some teachers made a point to review all the material that was covered in the course, assuming there would be

at least one question on the SOL end of year exam on each topic. Other teachers gave students choice on what topics they would focus their review. A third set of teachers focused their review time on topics they believed would be highly represented on the SOL end of year exam.

Mr. Green, for example, said, "[We try] to finish up about approximately a week prior to when we typically take the SOL. … Pre-remediation, if you will? Absolutely. Just kind of rehash topics" (J. Green, Interview, May 7, 2019). He built it into his timeline, and moved through the written curriculum faster in order to have a week of "pre-remediation."

Ms. Butler has done similar things in her classes:

> "My honors Algebra II class, we usually did like maybe three or four days. And what we did was we gave them, and we still do this as far as I know, we gave them a practice SOL. And then we use those results to guide. And again, it became a selection type of thing. Like, 'Okay, here's materials for every single standard. Which three standards do you need to work on the most?' And that's kind of how we went at it. But we didn't have to take a lot of class time to do it, but we did take some. And you know, it's a good time to talk about test taking strategies and using the calculator and kids would get mad at me, 'Why didn't you show us the calculator way the first time?' I'm like, 'Well because I actually wanted you to know that.' So, in my academic class we tend to spend a good bit more time. Usually that's at least a week, about a week and a half kind of reviewing those things. And it's more structured, so there's more time that we'll spend kind of up at the front of the board reviewing a topic. So usually there was like a 10- or 15-minute review at the beginning of the class and then we would break them off into whatever groups, kind of split the groups up and shift them around, and so forth based on what they needed to work on. And they got some choice too. They got to say, 'Okay, I want to work on this

> one ‘cause I'm most uncomfortable with it.’ Sometimes it was hard to get them go in that direction because they want to go to what they're comfortable with. Like no, you need to go where you're uncomfortable with” (L. Butler, Interview, June 7, 2019).

Ms. Butler found that providing students choice was very useful. She would let them make the decision on what topic(s) to review, sometimes with her encouragement towards a topic they found difficult. Ms. Butler shared that by providing students options and the ability to choose for themselves, she got a lot more buy-in from students.

For Ms. Butler, the amount of time reviewing for the end of year exams varied based on the level of the course. She did not feel as though she needed to provide her honors students with as much time as her academic level students. Ms. Cooper had a similar experience with her two courses, *Eighth-grade mathematics* and *Geometry*. She felt as though her students in *Eighth-grade Mathematics* needed more review and help using the online testing tools:

> “I was the one who kind of pushed for that week [of review]. We bled into it a little bit. But I kind of pushed for that in that I wanted to have a chance to go online, on the online testing and show them how to use the calculator, show them how to use the tools, make sure they were comfortable taking tests like on the computer. We spent some time like making like a card where like here are the 10 most important things you should remember, and when you get your paper, write down these 10 things, that kind of thing. So, we spent a lot of time doing that and I think that was helpful. I would have kept that. … I think a week is good. Too much more and the kids get antsy. But I don't know that I would cut it down much less than that. I felt like that was pretty good. It was enough to cover like two or three topics each day and get them a little practice on it.”

That is not to say that she did not do any review with her *Geometry* students. She did spend some time reviewing the online testing tools and theorems with students:

> "They really needed help with a compass on SOL 'cause that was weird and the calculator online, the graphing calculator, because that's new this year and they needed a lot of help with that. And then we did like two topics a day 'cause I feel like with Geometry there's so many, just like random theorems that they forget if they don't use them for a month or two. Like they had down all the stuff that comes up over and over, like the transversals and you know, all that stuff" (A. Cooper, Interview, May 31, 2019).

Two of the teachers mentioned wanting to have review time, or more review time, but running out of time. Because Ms. Darling reviewed foundational material and provided students with more time on earlier topics, her planned calendar had gotten pushed back and changed. That left her with only a few days for review for the end year exams.

> "So theoretically, the review three weeks for us would be like eight class periods. So twice as much time as we ended up having. … I spent a day on constructions a day on two-D and three-D, and then four class days on SOL review. So, it all got crammed because this (gesturing to triangles unit) didn't go well. And then those (gesturing to quadrilaterals unit) didn't go well and so then it spiraled to, we have no more time to do this or this or constructions. And still get review in, which [one of the other Algebra II teachers] was better at doing SOL review every day, but then she was teaching new material until like the day before the test. Whereas I squeezed it all in and then spent three days just being like drill and kill" (C. Darling, Interview, May 20, 2019).

Mr. Richardson also ran out of time for review.

> "[The other Geometry teacher] ended up, she was ahead of me and ended up with like a week for review and I did not, I was doing new stuff up until the last day. … I think, one of my, the way the schedule worked out, my A day Block had one day for review. My B day block did not. … I think I'm going to, now that I know more about what to expect, I'm going to start the review cycle earlier in the year, like probably right after spring break. And just to give you know, some time to put the review out, see how it's going" (S. Richardson, Interview, June 4, 2019).

This being his first year of teaching high school mathematics, Mr. Richardson did not prioritize review specifically for the end of year exam when making decisions. However, he has already begun to think about how he will make sure to include it in future years.

Review, of both material from previous mathematics classes and of material specifically for the SOL end of year exam, was a priority for all the teachers I spoke to in Pine Grove City Schools and Oak County Public Schools. All of these mathematics teachers had to use their experience and knowledge of students and the curriculum in order to find a way to make time for these various types of review.

Assertion 5

Assertion: Mathematics teachers in both Oak County Public Schools and Pine Grove City Schools used common assessments; however, these teachers did not feel as though the assessments made them alter their pacing when teaching various mathematics topics.

Mathematics teachers in Oak County Public Schools and Pine Grove City Schools all talked about common assessments. These assessments ranged anywhere from common weekly quizzes at Jefferson Middle School and Carter's Creek High School, to common unit tests, for example at Anderson High School, to common quarterly, midterm, and final exams, for example at Metro High School.

Ms. Cooper, a teacher at Johnson Middle School, used common assessments for her *Eighth-grade Mathematics* students. The assessments were created for every unit in collaboration with other *Eighth-grade Mathematics* teachers at her school. Ms. Cooper felt slightly more pressure to stay at the same pace as her colleagues, instead of moving faster:

> "We gave basically the same assessments every unit. … I think it will [affect my pacing for] next year. For the most part I felt like my students were grasping material quicker than the other two classes that my other teacher was teaching. … But I kind of felt like I needed to stay in pace with her just because we were doing everything pretty much like day to day together" (A. Cooper, Interview, May 31, 2019).

It is important though, that the only pressure for her in the *Eighth-grade Mathematics* classes was to slow down to keep pace with another teacher.

Ms. Cooper was the only *Geometry* teacher at Johnson Middle School though. She and *Geometry* teachers at Anderson High School, the school her students will be attending the following school year, used common quarterly assessments:

> "In Geometry I did a common assessment with the high school once a quarter. And that it was like 15 questions roughly of stuff for the quarter and they all always did fine. And I was like, 'All right, moving on.' You know, it was just kind of like one other thing to do almost. Kind of nice, I guess if there were any like glaring errors, but there never were. So, I just kind of moved on. … I think it was helpful for me just to make sure I was keeping up with what I was supposed to be doing. And I think it was helpful for them to be like, okay, I'm making sure my like standard level Geometry kids are still hitting these marks." (A. Cooper, Interview, May 31, 2019).

Because the students in Ms. Cooper's *Geometry* class at Johnson Middle School had been accelerated in mathematics curriculum, it is not surprising to me, that the common quarterly assessments did not affect Ms. Cooper when teaching these students who are advanced in their mathematics careers.

Ms. Darling, a teacher at Anderson High School, talked about the common assessments during the 2018-2019 school year. She said that there was a change during this school year, "There was also an emphasis this year on common planning, and common assessments, and common everything for everything. … [The] geometry [team] tried really hard to be, 'Hey, we're at least going to come up with common assessments that everybody could use'" (C. Darling, Interview, May 20, 2019). Ms. Darling knew that she was expected to give a common assessment for every unit. However, towards the end of the year she decided to not give the assessments because she needed the time to teach and prepare students for the SOL end of year exams: "I never used the one on circles or for that matter, right triangle trig either because there was no more time. Um, because for my children to do 15 questions, even 15 multiple choice questions, for some of them it literally takes the whole block" (C. Darling, Interview, May 20,

2019). None of the other *Geometry* teachers nor any of the school administrators came to Ms. Darling though and told her she had to give the assessments for circles or right triangles. Ms. Crawford, another teacher at Anderson High School, said that all mathematics teachers are expected to give the common assessments around the same time. However, she did not say that there were any repercussions for teachers who did not do so. Thus, these common assessments do not seem to affect teachers' pacing much.

Ms. Wilson, a teacher at Bakersfield Middle School, said that all the tests and quizzes she and the other *Algebra I* teachers give are common, though it does not affect her too much on her pacing:

> "Sometimes we tweak what day we're going to give it depending on how quickly students, 'cause the seventh-grade classes, they pick it up sometimes faster than the eighth graders, especially with the eighth graders that have skipped a year of math to go into Algebra. They sometimes need an extra day or two. So, I might delay the quiz or test a day or two depending on where my students are. But we follow pretty closely with each other" (L. Wilson, Interview, June 12, 2019).

Ms. Wilson and the two other Algebra I teachers at Bakersfield Middle School are not afraid to push back their common assessments if they feel it is necessary. Unlike Ms. Cooper, Ms. Wilson did not feel as though her students can go faster than the other classes. Therefore, when she wants to give her students extra time to work with a concept, she simply tells the other *Algebra I* teachers. If the other teachers thought their students were ready to take the quiz or test, they will either go ahead and give the assessment or provide extensions on the material. The common assessments provide guidance for Ms. Wilson; however, she did not express that they affect the pacing of her instruction.

Ms. Butler, a teacher at Carter's Creek High School, talked about how they have been using common assessments for more than 30 years:

> "We actually had common assessments long before common assessments were everywhere else. We used to give common [midterm and final] exams. You know, when I first started teaching here, we all gave every geometry kid the same exam. Every Algebra I kid got the same exam. So, we were doing that when I came here. … We were doing common assessments then, you know, to look at data - compare across teachers and classrooms. So, we've done for as long as I can remember now. But since we've gone to standards-based grading, we do quizzes and we typically will give the same quizzes. Occasionally a teacher, like [Mr. S] for example, would be ahead of me. So, he might add a standard onto his that I didn't put on mine, but we pretty much gave the same kinds of questions and that sort of thing and reassessments and all that" (L. Butler, Interview, June 7, 2019).

Ms. Butler did not seem concerned when Mr. S was ahead of her and had additional standards on his quizzes. She knew she was going to be giving a common quiz at the end of each week, and would only include put standards she covered in her class. Like other mathematics teachers in both Pine Grove City Schools and Oak County Public Schools, all of whom talked about common assessments in terms of quizzes and tests, Ms. Butler's pacing was not largely affected by the assessments.

Other Supports for Assertions

These assertions from my interviews are supported by other data – an interview with the district mathematics coordinator and observations of professional development.

Division Mathematics Coordinator

While the assertions were being finalized, I asked Ms. Smith, the Division Mathematics Coordinator for Pine Grove City Schools, to read them. Ms. Smith is in her fourth year as coordinator for the district. Prior to having this administrative position, she taught mathematics for eleven years in middle school. For six of those eleven years, Ms. Smith was also a mathematics coach in Bakersfield Middle School. I interviewed Ms. Smith after my data collection to gather her thoughts on the five assertions. She said that she has been hearing comments from the teachers she oversees that are consistent with Assertions 1 – 4. Ms. Smith said, "[These assertions] are definitely things I have heard and deal with" (C. Smith, Interview, October 23, 2019).

Ms. Smith said she heard comments from teachers about the usefulness and benefits of common pacing guides, as expressed in Assertion 1. She appreciates this finding because it confirms that teachers are teaching the written curriculum instead of only teaching what they want to teach. She is aware that teachers are trying to keep at similar pacing. Ms. Smith also tries to check in with the new teachers in her district and help them acquire the materials they need. Through this part of her job she knows these new teachers are using and referring the pacing guides when planning.

Ms. Smith acknowledged that teachers restrict their teaching by not going into depth and cut material, as reflected in Assertion 2. However, she went on to say that she thinks teachers could do a better job of working in all the written curriculum. She said, "If teachers can set up spirals, cumulative tests, etc. then they can spend more time on topics instead of stopping to review a month plus before the exam" (C. Smith, Interview, October 23, 2019).

When discussing Assertion 3, which was concerned with experienced teachers using their knowledge to adjust pacing guides as they see fit and novice teachers relying heavily on the

pacing guides provide, Ms. Smith agreed. She said that teachers use their expertise, also known as their MKT, to prepare their calendar to spend time on areas that often cause problems for students. The novice teachers do not have anything to compare the pacing guides to and so they trust the guides to give them the appropriate timing. Ms. Smith shared that she sees this finding often when she attends team meetings. The veteran teachers discuss adjustments to the pacing guides, while the novice teachers stay quiet and listen intently.

Ms. Smith said that she is aware that teachers feel as though they have to pause their teaching in order to review foundational material and/or topics covered on the end of year exams, as discussed in Assertion 4. However, she seemed a bit disheartened by it. She said it largely depends on where the teachers are and the resources available to them when considering how they can work with students on reviewing material. For example, the 7th-grade Mathematics team at Bakersfield Middle School is moving to providing remediation for students at least two days each week. She said these are fluid groups and the remediation lasts between 30 and 45 minutes. Bakersfield Middle School is able to do this though, because they have mathematics classes every day for 90 minutes. Not all schools have set up their schedule in this manner and therefore cannot provide as much remediation during school for students.

Finally, Ms. Smith was surprised by the fact that teachers shared that common assessments do not affect their pacing. Although she believed the findings, she was a bit shocked because she believes common assessments should be altering teachers' pacing through content. Over the past four years, she has had to spend more of her time working with elementary teachers. Therefore, she might not know what is happening in the secondary mathematics classrooms. Ms. Smith thinks teachers should be at similar places in the curriculum and use the data from the common assessments to adjust future teaching.

As Mathematics Coordinator, Ms. Smith is very invested in helping all mathematics teachers find success. She believes that "having a pacing guide is helpful to new teachers. And when [teachers are] tight with pacing guides and data, it's possible to fit everything in. I have seen crappy pacing guides [in other places] where they don't drill down and that's when teachers have issues" (C. Smith, Interview, October 23, 2019).

Observations of Professional Development

The assertions are also supported by my observations of elementary teachers during the summer of 2017 professional development. Teachers participated in this pacing guide creation week because they thought it would be valuable to teachers, consistent with Assertion 1. When working with these men and women, I noticed the teachers did not talk about including review time in the pacing guides they were writing. They struggled a lot with how to fit all the topics from the written curriculum into the school year, and did not have any additional time for teachers to review. This supports Assertion 4 – teachers had to find time on their own to work in review. The teachers working on these pacing guides also consciously made the choice to limit the amount of detail in the pacing guides. They did not want to overwhelm other teachers with the length of the documents. However, this is the detail new teachers, such as Mr. Richardson and Ms. Cooper, said they would have liked, as stated in Assertion 2.

Revisiting Research Questions

1. What benefits and concerns do teachers find with pacing guides?

The three benefits teachers see in having pacing guide, (1) keeping teachers close to the same pace, (2) helping new teachers plan, and (3) provide accountability to the written curriculum were discussed Assertion 1. Concerns that were discussed, such as having to cut material and explorations/applications and including time to review were expressed in Assertions 2 and 4.

2. What changes do teachers make regarding curricular pace and sequencing relative to what is stated in pacing guides given by the school district?

Following the concerns the teachers had, Assertion 2 addresses this question in terms of cutting material and restricting explorations of topics. Assertions 4 and 5 also work to answer this question when considering working in review time and common assessments.

3. How does teacher experience affect their use and/or adaptation of pacing guides?

Assertion 3 speaks to this question specifically. It addresses teacher experience and adaptations of pacing guides. Assertion 3 also discusses new teachers' frustrations with pacing guides that limit the amount of information provided.

Chapter V: Discussion and Implications

The problem of practice I investigated with this study was how mathematics teachers use curricular reasoning to balance the need to cover all the topics in the written curriculum, as presented in the pacing guide, with the goal of teaching fewer topics well and reviewing prerequisite material as needed. I looked at the reasoning mathematics teachers went through when navigating between the written, intended, and enacted curriculum. Mathematics teachers are expected to teach all of the material in the written curriculum well. However, many teachers believe that this is not always feasible because not all students are prepared sufficiently and/or can follow at the suggested pace. These decisions are part of the curricular reasoning process mathematics teachers use when deciding what and how to teach their students.

My findings from this research are summarized in the following five assertions:

1. Mathematics teachers in Oak County Public Schools and Pine Grove City Schools believe common pacing guides are beneficial for at least one of three reasons. Following pacing guides can: (1) keep all teachers at close to same pace across the schools; (2) help new teachers plan; and/or (3) provide accountability to the written curriculum.
2. Because there were so many topics in the written curriculum to cover mathematics teachers took at least one of two actions: (1) they restricted their teaching by either eliminating the teaching of applications or not going into deeper explorations of topics; and/or (2) they cut out material in order to spend more time on topics they deemed more important because the "important" topics were foundational for subsequent mathematics classes and/or on the SOL end of year exams.
3. Experienced teachers adjust school or district pacing guides based on their own experience teaching the content and working with students. These adjusted pacing guides are deemed by the

teacher as more appropriate than the given ones for approximating the amount of time they expect to spend on each topic. Novice teachers, on the other hand, relied on either the given pacing guides or the ones adjusted by their more experienced colleagues.

4. All teachers tried to include time in their course to review foundational topics and/or topics that would be included on the exam.

5. Mathematics teachers in both Oak County Public Schools and Pine Grove City Schools used common assessments; however, these teachers did not feel as though the assessments made them alter their pacing when teaching various mathematics topics.

[To be included this week- interview with mathematics district lead]

Discussion

Assertion One, on the benefits of pacing guides, is similar to what other studies have found when considering new teachers. David (2008) recognized that some teachers, especially new teachers and/or teachers teaching a course for the first time, found pacing guides to be exceedingly helpful. The pacing guides provide direction on what the "school expects them to teach" (p. 87). Bauml (2015) also had similar findings - new teachers welcomed pacing guides as content guides, especially at the beginning of the year.

None of the studies I was able to find mentioned keeping teachers close to the same pace between schools in a district. I believe this is an important aspect to consider though, because there are students who move between schools. When a student enters a class after the school year began, the teacher has to determine what he/she already has learned. If that student moved from a school in the same district with common pacing guides, the teacher would not have to worry as much. The teacher would be able to work off the knowledge that the other mathematics teacher follow similar sequencing and pacing.

I was also unable to find any studies that investigated mathematics teachers' fidelity to the written curriculum. It is generally accepted that there will be some changes between the written curriculum and the enacted curriculum, as explained in Stein and Smith (2010), however I am unaware of any studies that investigate how much change occurs and how those changes are decided upon. I believe this is where teachers' MKT and curricular reasoning make major impacts. The teachers are the ones who take the written and intended curricula and make decisions about what and how to teach it to their students, resulting in the enacted curriculum. As Ball et al. (2008), Breyfogle, McDuffie, and Wolhuter (2010), and Dietiker et al. (2018) discuss this is the natural progression of teachers.

Assertion Two, on making it through the written curriculum, relates to David (2008) and Bauml (2015) as well. In her review of the literature, David found that teachers deal with the pressure of covering all the material in at least one of four ways: (1) prioritizing tested topics (aka teaching to the test); (2) using direct instruction instead of student-centered lessons; (3) lowering the cognitive demand of activities; and/or (4) prioritizing breadth over depth. These are similar to what I found, especially prioritizing tested topics and breadth over depth and lowering cognitive demand. Teachers felt they had to eliminate teaching applications of mathematics, deeper explorations, and in some cases, even certain topics. These actions were taken in order to spend more time on tested topics or reviewing material. The teachers felt guilty for eliminating applications and not allowing students to explore mathematics. Ms. Butler, for example, said that she "fell in love" with mathematics by seeing applications and being able to explore how concepts connected. She wanted students to ask questions about the mathematics and find similar enjoyments, but often had to cut off the students' explorations because of time constraints. All the teachers I spoke to also felt as though they had no other choice since there is so much

material in the written curriculum. Bauml (2015) also stated that her participants did not feel as though they had enough time to allow the students to fully master one topic before having to move on to the next topic. However, because there was so much for them to teach, the teachers in Bauml's study had to keep moving and found other methods to fit in all the material.

Assertion Three, on using experience and MKT to make necessary adjustments to pacing guides, has many ties to the literature. Cobb et al. (2003) found that as the school year progressed, teachers began to deviate more and more from the pacing guides. They began using their knowledge of students and material – their MKT – to adjust the pacing for their students. Bauml (2015) also found that as the year progressed, teachers had to adjust their pacing for their students.

It is also in this third assertion where teachers' curricular reasoning can be seen best. Breyfogle, McDuffie, and Wohlhuter (2010) created a curricular reasoning model, displayed in the second chapter in Figure 11. This model includes the aspects of curricular reasoning, curricular knowledge, curricular vision, and curricular trust teachers consider when deciding what, when, and how to teach content. This can be seen in my study, for example when Mr. Richardson decided to change sequencing of topics from the previous year, by considering what adaptations teachers make to pacing guides and the reasoning behind those decisions.

Dietiker et al. (2018) also created a framework for curricular reasoning, recreated in Figure 12 of chapter 2, which they called curricular noticing. This includes many of the same aspects as Breyfogle, McDuffie, and Wohlhuter (2010), but with different names. Like with the curricular reasoning model created by Breyfogle, McDuffie, and Wohlhuter, the aspects of curricular noticing can be seen when the teachers in my study made adaptations to pacing guides, for example when Ms. Darling and her colleague decided to condense the unit on circles into a

couple of days. Curricular attending, curricular interpreting, and curricular responding are all evident in teachers' MKT and curricular reasoning as they adjust to their students. These skills and knowledge are developed over time. This is why veteran teachers are able to make more appropriate adjustments to pacing guides than their novice colleagues. The novice teachers have not developed their own MKT yet. They will eventually be able to use their experience to make necessary adjustments though.

Assertion Four, discussing time to review both foundational information and topics included on the SOL end of year exams, also demonstrates teachers' curricular reasoning. Veteran teachers, who have stronger MKT than their novice colleagues, know what foundational information students will need to understand the topics they are to teach. Therefore, these teachers try to make sure their students have a strong grasp of the foundational material. For example, Ms. Cooper and her colleagues shared that they had to begin the school year with a unit on numbers and number relationships before they could continue with teaching the Eighth-grade mathematics curriculum. The veteran teachers with stronger MKT are also able to anticipate where students will have difficulties based on missing prior information. Mr. Green, for example, shared that he learned "anything with an F causes students trouble – fractions, factoring, etc" (J. Green, Interview, May 7, 2019). These veteran teachers use their experience of working with students for multiple years to know what students enter their class not knowing. Veteran teachers have also been through multiple years of SOL end of year exams. They tend to anticipate which topics will be asked about more frequently. Therefore, they focus their review time on those topics.

Assertion Five, on common assessments, does not have any relation to the literature reviewed in this study. However, it was interesting because none of the teachers I talked to felt as

though the common assessments affected their pacing. I would have expected some teachers to say that at least some of them felt as though they had to speed up their teaching in order to give the common assessment at a similar time to their colleagues. Common assessments was not a focus of this study, however, I would have expected them to have an impact on teachers' curricular reasoning.

Recommendations

Based on the findings of this study, I provide the following recommendations to school districts, schools, and mathematics teachers.

1. School districts should continue to offer pacing guides to teachers. It is important to note that because of adaptations will be made, these should be viewed and used as a *guide* though. The teachers need to feel as though they can adapt the pace and material as needed for the students in their classroom. This does pose some tension with the idea of accountability to the written curriculum, as discussed in Assertion 1. Teachers need to feel the ability to adapt but also be held accountable to teach all the material.

2. As school districts continue to provide pacing guides, the pacing guides should provide more detail for new teachers or those teaching a course for the first time. As the novice teachers in this study expressed, more information would be helpful. Assertion Three discusses novice teachers' growing MKT. The learning process for novice teachers needs to be supported with additional detail on pacing guides.

3. Pacing guides should also include time to review. As Assertion Four states, all teachers who participated in this study tried to include some time to review foundational material for their subject area and/or review of material before the required end of year exams. Pacing guide creators should recognize the need for both these review times and include it in the pacing. This

would mean having to increase the pace in some areas in order to fit in the reviews. This does present another source of tension. Teachers are already doing this on their own though, so it is possible. Some of the basis that teachers use when making curricular decisions is based on their knowledge of the difference between the written/intended curricula and the tested curricula. They use this knowledge to determine where to spend their instructional time. Also, as the district coordinator said, teachers should spiral back as review for students.

4. Teachers who are successful at teaching all the written curriculum, usually veteran teachers, need to be willing to work with their novice colleagues. These veteran teachers can help their fellow mathematics teachers in finding topics to combine and share useful resources with one another. There also needs to be time given to these veteran teachers in order for them to meet with their colleagues who are having difficulty and assist them in finding similar success. I believe there should be more mentoring between teachers in general. Traditionally, schools offer mentors for first year teachers. This should be ongoing past the first year as novice teachers begin to develop their own MKT. Teachers who have many years of experience and well-developed MKT should be the mentors to assist the young teachers in their curricular reasoning.

5. Teachers should be provided more professional development on how to develop lessons that cover more than one topic at the same time in order to develop their MKT. Other useful professional development could also include other effective ways to teach the material. It is important that the professional development be relevant to the teachers and address their needs. There is a lot of material to teach in the school year. There should be constant sharing of methods to effectively teach all the topics.

6. Schools should continue, or begin, to offer other creative solutions to assist teachers and students in managing the amount of material there is to cover in a single academic year.

- One possible solution is be to offer summer school for students who finished the previous course without solid understanding. This might be problematic for some families, so as an alternative schools could offer students the opportunity to begin school a week early to review material to get a jumpstart.
- Another solution would be to require students to take a co-requisite, as many community colleges are beginning to do. This would allow the teacher to provide the support the students need on the foundational material while not taking up time in class. One problem with this is that the students would have to drop another class in order to fit in this additional mathematics class.
- Some schools also offer Saturday enrichment as an opportunity for students to receive additional instruction on material they are learning in class. The school might also bring in tutors during school or after school to provide one-on-one support for students. Both of these ideas need to be implemented early in the school year though. The school should not wait until the last month before the required end of year exams.

There are other possibilities for how to handle this situation. These are just a few examples, and may not work in every school. Teams of stakeholders (administrators, teachers, and parents) should work together to brainstorm various ideas that would work for their school and students.

7. Finally, administrators need to acknowledge the struggle of teachers who are trying to teach all the written material well. This leads to tough decisions by teachers as explained in the Assertion Two. Teachers are struggling to get through the entire written curriculum before the end of year exams. This is where their curricular reasoning happens.

Limitations

This study was limited in multiple aspects – two of the most prominent being timing of the study and number of teachers interviewed. I conducted this study during the summer of 2019. Therefore, I was unable to observe how teachers worked with one another in order to adjust pacing guides for their students. It would also have been beneficial if I had the opportunity to talk to mathematics teachers as they were making adjustments during the school year. Teachers have to adapt to how slowly or quickly their students are understanding the material. These in-the-moment decisions are valuable and interesting when considering curricular reasoning.

Only studying Oak County Public Schools and Pine Grove City Schools also limited me. I think it would be very interesting to study a very large school district. I hypothesize that mathematics teachers in a large school district would make more adaptations to pacing guides to fit their students.

Future Research

I believe more studies should be done to understand the decisions teachers make when moving between written and enacted curricula. This is done by teachers every day across the country. However, there are few studies investigating teachers' curricular reasoning which guides this process.

I also believe that future research should be done including more teachers and in various school districts. As I mentioned in the limitations, these teachers should be interviewed and observed during the school year. This would allow future researchers to include planning meetings to hear the curricular reasoning that occurs during the meetings.

Finally, I think that pacing guide creators should be specifically included in future studies. These people are often teachers and mathematics specialists. They also go through

curricular reasoning when creating the pacing guides. I believe this to be useful and valuable information.

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APPENDICES
Appendix A

Initial Teacher Semi-Structured Interview Protocol

"The purpose of this interview is to understand to what degree, if any, how and why mathematics teachers use and/or adapt pacing guides for their instructional purposes and how these guides affect teachers' curricular reasoning. I want to try to understand the reasons behind the curricular decisions you make in terms of sequencing and pacing. Our interview will focus specifically on your actions in terms of curricular planning and the reasoning behind those actions. This interview will help set the stage for a second interview that will follow up on your reasoning."

Teacher Name: _____

Interview Date: _____ Time: _____

Location of Interview: _____

1. How long have you been teaching?
    a. Has that whole time been in Virginia or have you moved from another state?
        i. What state?
    b. Has that whole time been in ___ district or did you move from another district?
        i. What district?
2. What course(s) do you teach now?
    a. Have you taught this course your entire teaching career?
        i. What other courses have you taught?
3. Let's focus on one course. Which course would you like to talk about? _____

    Do you create any whole year course plan?
    a. How do you plan your instruction for an entire school year?
    b. What materials are provided to you by your district? What materials are provided by your school?
        i. How do you use those materials?
    c. Do you use any curriculum guides/textbooks/other materials influence you planning in terms of sequencing and pacing?
        i. If so, how?
        ii. If not, why not?
    d. Are you provided a pacing guide by your district?

i. If so, do you use it?
    1. If you do, why?
    2. If you do not, why not?
ii. If so, does it affect your planning?
    1. If yes, please describe how.
        a. Probe for answers in terms of both sequencing and pacing.

4. How do you decide on what you consider appropriate sequencing for a specific class?
    a. What are some of the characteristics of the students that affect your sequencing?
    b. What are the characteristics of the materials that affect your sequencing?
5. How do you decide on what you consider appropriate pacing for a specific class?
    a. What are some of the factors that affect your planning of pacing?
    b. Are there any systemic interruptions that affect your pacing?
6. Do you make ever adaptations/have you ever made/do you plan to make to the pacing guide?
    a. What kinds of adaptations?
        i. Why did you decide to make these changes?
        ii. How effective do you believe your changes were?
            1. How do you know?
    b. Here is a copy of your district's pacing guide. (Course: _____) Can you provide specific example(s) from your course where your instructional pace and sequencing was very similar to what was stated in the pacing guide?
        i. Feel free to mark it up.
        ii. Why did you decide to follow it as closely as you did?
        iii. How well did it work?
    c. Can you provide specific example(s) from your course where your instructional pace and sequencing was very different from what is specified in the pacing guide?
        i. Feel free to mark up the pacing guide.
        ii. Why did you decide to deviate?
        iii. How well did it work?

7. Do you know where your pacing guide comes from, who wrote it, and/or how it is created?
    a. If so, please describe what you know.
8. Did you inform anyone about your adjustments as potential revisions for future pacing guides?
    a. If so, please describe that process
9. Have you ever experienced any tensions between wanting to slow down your pace of instruction but also getting through all the content by the end of the year?
    a. If so, please describe those tensions.
        i. Please provide a specific example, if possible.
    b. How did you manage those tensions?
10. Do you feel that there is an expectation from your administrators/mathematics leads/department chairs to closely follow the pacing guides as written?
    a. Can you describe these pressures?
    b. How do you deal with these pressures, especially when you want to change instructional pace or sequencing when compared to the pacing guide?
11. It has been stated, “Pacing guides provide guidance to teachers about both sequence and the amount of time spent on topics.”
    a. To what degree do you agree or disagree with this?
12. In the literature it is stated that pacing guides can inhibit some teacher’s abilities to adapt instruction as needed to the students in their classrooms.
    a. To what degree do you agree or disagree with this?

Appendix B

Example of Pacing Guide provided by Mr. Richardson

Geometry Curriculum Continuum

2016 Standards of Learning

Geometry SOL Blueprint

ACPS Calendar	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 9
1st Quarter 49 days AUGUST 22 NOVEMBER 1	**Unit 1:** G.3 (a,b, c, d)) Geometry Essentials, Symmetry & Transformations 1 Common Formative Assessment (Real World Application)				**Unit 2:** G.2 & G.1 Reasoning 1 Common Formative Assessment (Real World Application)			**Unit 1 & 2** P-Based Summative Assessment
2nd Quarter 39.5 days NOVEMBER 7 JANUARY 18	**Unit 3:** G.5, G.6, G.7 and G.8 Triangles 2 Common Formative Assessment (Real World Application & Technology Enhanced)							**Unit 3** P-Based Summative Assessment
3rd Quarter 45.5 days JANUARY 23 MARCH 27	**Unit 4:** G.4 (a, b, c,d,g,h), G.9 and G.10 Quadrilaterals, Constructions and Angles 1 Common Formative Assessment (Real World Application & Technology Enhanced)					**Unit 6:** G.11 & G.12 Circles 1 Common Formative Assessment (Real World Application & Technology Enhanced)		
4th Quarter 31 days APRIL 8 JUNE 6	**Unit 6:** Circles Continued	**Unit 7:** G.13 & G.14 2-D & 3-D Geometric Figures 1 Common Formative Assessment (Real World Application & Technology Enhanced)			**Unit 8** SOL Targeted Review			**Common** **P-Based** Learning Experience

WEEK 8 EXPECTATIONS

- ❑ Administer Common Benchmark Assessment
- ❑ Fill knowledge gaps for struggling learners and enrich advanced learners
- ❑ Analyze student learning data for targeted intervention planning with PLC
- ❑ Share common assessment data with PLC on Geometry Inclusive Data Sheet

1st Qtr (Week 8): Predictor A
2nd Qtr (Week 8): Benchmark
3rd Qtr (Week 8): Predictor A