

Summer 8-1-2017

# A Comparison of Complex Thinking Required by the Middle School New Jersey Student Learning Standards and Past New Jersey Curriculum Standards

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**A Comparison of Complex Thinking Required by the Middle School New Jersey Student Learning Standards and Past New Jersey Curriculum Standards**

**by**

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Dissertation Committee

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Submitted in partial fulfillment of the requirements for the degree

Doctor of Education

Department of Education

Seton Hall University

2017

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**SETON HALL UNIVERSITY**  
**COLLEGE OF EDUCATION AND HUMAN SERVICES**  
**OFFICE OF GRADUATE STUDIES**

**APPROVAL FOR SUCCESSFUL DEFENSE**

**Clifford Burns**, has successfully defended and made the required modifications to the text of the doctoral dissertation for the **Ed.D.** during this **Spring Semester 2017**

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## **Abstract**

Learning standards define what knowledge and skills students need to master in order to be prepared for college and careers. The acquisition of knowledge and skills is essential for the 21st century learner as students are required to think, problem solve, create, and communicate for future employers. The best 21st century learning standards are those that provide the opportunity to develop complex thinking skills including creativity, strategic thinking, and critical thinking. This dissertation sought to examine the cognitive complexity of the newly adopted New Jersey Student Learning Standards (NJSLS) in Grades 6–8 mathematics as compared to the cognitive complexity of the New Jersey Core Curriculum Content Standards (NJCCCS) in Grades 6–8 mathematics using the Webb’s depth-of-knowledge framework. This study aimed to reveal the extent that complex thinking skills are incorporated throughout these two specific sets of learning standards.

This study utilized a qualitative content analysis using Webb’s depth-of-knowledge methodology to code the learning standards in both the NJSLS and NJCCCS. Deductive category application was used to connect Webb’s depth-of-knowledge framework to the existing NJSLS and NJCCCS. Each depth-of-knowledge level represents a specific level of cognitive complexity. The higher the DOK level of a standard, the higher level of cognitive complexity is contained within that specific standard. The higher the cognitive complexity of a standard, the more complex thinking is embedded into that standard. Each standard was rated on a 1–4 DOK level based on Webb’s depth-of-knowledge methodology. To assist with reliability in coding each set of learning standards, a “double-rater read behind consensus model” was implemented as in other similar studies.

The major findings identified when the mathematics Grades 6–8 NJSLS and the mathematics Grades 6–8 NJCCCS were compared using the DOK framework were:

1. The mathematics Grades 6–8 NJCCCS were rated at an overall higher percentage of DOK Levels 3 and 4 than were the mathematics Grades 6–8 NJSLS.
2. The mathematics Grades 6–8 NJSLS contained a higher percentage of lower rated standards, DOK Levels 1 and 2, as compared to the mathematics Grades 6–8 NJCCCS.

This study suggests that more opportunities for developing complex thinking, which is essential to 21st century learning, is contained within New Jersey's older, replaced set of learning standards found in the mathematics Grades 6–8 NJCCCS when compared to the newly adopted mathematics Grade 6–8 NJSLS.

Keywords: Common Core State Standards, Complex Thinking, Standardization, New Jersey Student Learning Standards

## **Dedication**

The doctoral journey is much like a marathon race, requiring discipline, endurance, and an unrelenting desire to succeed. Unlike a marathon runner, my doctoral journey was far from a personal accomplishment, as I also relied on the supports and encouragement given by those who know me and love me most. Furthermore, it is only suiting to dedicate this dissertation to these same people who cheered me on from beginning to the end.

To my faithful and loving wife Gretchen, I am so thankful for your sacrificial love in supporting me on this journey. The working nights, weekend classes, and summer commitments were difficult, but your love shined through. You truly are my best friend, and I am so thankful to God for such an incredible person to share this life with.

To my mom and dad, thank you for modeling only the best attributes. To my father, you showed me how hard-work and perseverance pays off and how laughter makes life that much sweeter. To my mother, you showed me what true acceptance and commitment is and how love and family are the most precious gifts in the world. Thank you both for loving me through the peaks and valleys of my life and always being supportive of my ambitions and pursuits.

To my three brothers, thank you for your friendship, love, and support. I am so appreciative of the bond we share and how we spur each other on to be only the best versions of ourselves. Although there is distance between the four of us, we never cease to encourage one another through the successes and failures that arise. I am truly grateful for the memories and experiences we share that further unite us.

To my three sons, you are my pride and joy, and I am so thankful to have the privilege of raising you up to be leaders, providers, and difference makers for the next generation. I hope to model your true masculinity in the form of faith, love, commitment, strength, and perseverance. May you utilize your God-given gifts to bring honor to Him as well as your family.

## **Acknowledgements**

This doctorate has always been a dream, a dream that is now a reality thanks to those who helped to guide me through this process. I would like to acknowledge the professionalism and mentorship of Dr. Christopher Tienken over the last two years. It was Dr. Tienken's enthusiasm and conviction of providing only the best curricula for students that aided me in my quest to evaluate learning standards for essential complex thinking skills. I am so thankful for Dr. Tienken's guidance, correction, and gentle push that enabled me to build a quality research project with practical application for practicing administrators. I would also like to thank my readers in Dr. Luke Stedrak and Dr. Dennis Copeland for their words of encouragement and feedback to make my dissertation the best it possibly can be.

Also, I would like to acknowledge Seton Hall University where I have completed both my master's and doctoral degrees in educational leadership. Seton Hall University has created quality degree programs that I feel have adequately prepared me for the rewards and challenges of service in public education. Relatedly, I am thankful for my cohort members who encouraged and supported me from the start of our program to the very end. To our benefit, we are a diverse group, spanning many states and serving in many different positions. However, we were united in our thirst for life-long learning and a sincere desire to utilize this doctoral degree to expand our sphere of influence. I am honored to call you friends and colleagues.



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## Chapter I

### Introduction

Some commentators in the education and business literature state it is important to develop skills and dispositions related to complex thinking in students in order for them to become globally competitive (Standard Chartered Global Focus, 2010; World Economic Forum, 2015). In addressing the personal characteristics most critical for employees' future success, CEOs from 1700 of the world's best businesses ranked creativity above being opportunity seeking, technology-savvy, and globally oriented in a recent survey (International Business Machines [IBM], 2012). CEOs most frequently stated they need employees who can problem solve, think creatively, and work well with others on key tasks. *The Competitiveness and Innovative Capacity Report* states that "given the pace of change in today's global economy, investments to promote innovation deserve more emphasis than at any other time in the past" (U.S. Department of Commerce, 2012, pp. 2–3).

Commentators on global competitiveness use the terms cognitive complexity, creativity, innovation, analytical thinking, and problem-solving skills as proxies for the overall basket of future-ready skills known as 21st century skills (Binkley et al., 2011). Creativity, innovative thinking, critical thinking, and problem solving are examples of complex thinking deemed essential for future economic success in the mainstream education and business literature.

Whether a high school graduate plans to directly enter the workforce or attend a vocational school, community college, or university, he or she must be able to think creatively and solve problems, communicate effectively, collaborate, find and assess information quickly, and effectively use technology. (Soulé & Warrick, 2015, p. 178)

With so much emphasis on developing the complex thinking skills and dispositions in students, it is essential that educators, administrators, and policymakers evaluate current

curricula to ensure that they are truly designed to cultivate those types of skills and dispositions. The claim (CCSS) developers publically declare is that these standards result in students who are more creative and ultimately better prepared for college and careers, and it must be tested for accuracy.

### **The New Jersey Core Curriculum Content Standards**

The New Jersey Core Curriculum Content Standards (NJCCCS) were first adopted by the State Board of Education in 1997. The original NJCCCS and the corresponding state tests were not the result of extensive curricular research. Rather, the NJCCCS were imposed by the Whitman Administration as part of a lawsuit, known as Abbott versus Burke, over New Jersey's school funding formula. Her administration was charged with determining how much a "thorough and efficient" education would cost in New Jersey to meet the mandates in the Comprehensive Educational Improvement and Financing Act (known as CEIFA). To do this, the Whitman Administration tasked the New Jersey Department of Education (NJDOE) with creating a set of curriculum standards to define the "thorough and efficient" mandate in the state constitution so her administration could determine these cost values for education in New Jersey to support her suggested state funding levels. Thus, New Jersey's first set of mandated curriculum standards and high-stakes tests were created to satisfy legal and political mandates, not for educational reasons (Tienken, 2015).

The NJCCCS set curricular expectations of student output at each grade level. The New Jersey Standards describe what students should know and be able to do at each grade level beginning in kindergarten through high school graduation. Policymakers decided to abandon the NJCCCS Mathematics and English Language Arts (ELA) standards in 2010 due to the question of whether the standards resulted in students who were equipped with the high-level thinking

skills identified in the business literature as necessary for an uncertain future. According to NJDOE College and Careers Readiness Task Force (2012):

There is growing concern among educational and business and industry stakeholders that the language arts and math standards and the assessment tools used to measure students' achievement of those specific standards do not always adequately measure student preparedness to meet present and future college and career needs. (p. 11)

This task force would ultimately recommend replacing the NJCCCS with the Common Core State Standards (CCSS) in ELA and Mathematics for the students in New Jersey.

### **The Common Core State Standards**

The Common Core State Standards, adopted by the New Jersey State Board of Education in 2010, only 2 weeks after the final drafts of the standards were released, define grade-level expectations from kindergarten through high school of what students should know and be able to do in ELA and Mathematics to be successful in college and careers (CCSS Initiative, 2017). Two private organizations, the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) led the development and marketing of the Common Core State Standards. As of July 2015, forty-two states, the Department of Defense Education Activity, Washington DC, Guam, the Northern Mariana Islands, and the U.S. Virgin Islands adopted the CCSS in ELA/Literacy and Mathematics (CCSS Initiative, 2017). Officials at the NGA and CCSSO contend that the standards emphasize the critical thinking, problem-solving, and creative skills business leaders are looking for in students, thus making students ready to succeed in higher education and careers. Officials at the CCSSO posted the following declaration about the standards:

Across the country, states have chosen to upgrade their standards by adopting and implementing either the Common Core State Standards or other college- and career-ready standards. As a result, students are gaining a deeper understanding of subject matter, are learning to think critically, and are applying their learning to real-world problems. (CCSSO, 2017, p. 1).

Relatedly, the Common Core State Standards Initiative (CCSS Initiative, 2017) Website claims, “The Common Core focuses on developing the critical-thinking, problem-solving, and analytical skills students will need to be successful” (p. 1). Advocates for the CCSS also state that this curriculum will benefit students by bringing about equality, regardless of socioeconomic status or geographic region, resulting in all students receiving the same required knowledge. After political pressures from Governor Christie to revise the CCSS for the state of New Jersey, the State Board of Education in May 2016 gave final approval to the New Jersey Student Learning Standards (NJSLS), which outline what skills students should learn at each grade level (Clark, 2016). As noted in the next chapter, there are minimal differences between the CCSS and the NJSLS being implemented during the 2017–2018 school year throughout the state of New Jersey.

### **21st Century Skills: Creativity & Strategic Thinking**

Creativity has been described as complex, vague, and elusive, evading definition and categorization (Burnard, 2006), yet some attempted to define it in the education and business contexts. Creativity is typically described as the process of generating new ideas, whereas innovation takes creativity a step further by being a process that turns those ideas into reality (Brown & Kuratko, 2015). Sternberg (1996) defined creativity as a process that requires the balance and application of three essential aspects of intelligence: creative, analytical, and



practical. Creative intelligence refers to the ability to go beyond the given to novel and interesting ideas. Analytical intelligence is required to analyze and evaluate the new ideas so as to filter the better ideas from the weak ones. Practical intelligence is required for the translation of theory into practice and abstract ideas into practical accomplishments (Tan, 2015).

Cognitively, creative people have been described as: being able to think metaphorically and flexibly, independent in judgment, skilled in decision making, able to cope well with novelty and ambiguity, willing to take risks, able to play with ideas internally, able to break away from set ways of thinking, question norms and assumptions, and alert to novelty and gaps in knowledge (Tan, 2015). Despite its importance, creativity, especially in curriculum domains other than the arts, appears to be neglected and undervalued (Rodd, 1999).

Zhao (2012) stated that the most desirable education is one that enhances human curiosity and creativity, encourages risk taking, and cultivates the entrepreneurial spirit in the context of globalization. Zhao's conception of creativity not only serves the individual interests of the student but is a necessary task for equipping a skilled, competitive work force. In traditional methods of instruction, the student is rarely allowed to practice on problems that require innovative modes of thought for their solution (Covington, 1968).

In Webster's New World Dictionary, the word *creative* has three interrelated meanings: 1. creating or able to create, 2. having or showing imagination and artistic or intellectual inventiveness, and 3. stimulating the imagination and inventive powers. Contrary to popular belief, creativity is developed through years of practice and commitment rather than it being an innate talent (Elder & Paul, 2007). Instead of simply imparting knowledge, it is vital that teachers instruct children how to think, so that children can learn to make use of information (Covington, 1968; Rodd, 1999). Twenty-first century learners need more than facts and figures.

They are required to think, problem solve, create, and communicate, for these are the timeless traits modern day employers are desperately seeking (McLaughlin, 1992).

Complex thinking skills are often characterized on a continuum of levels. Lower levels of thinking are simpler (memorizing, identifying, etc.) than higher, more complex levels (synthesizing, judging, analyzing, etc.). Differentiating curriculum to increase the complexity of the thinking involved means the learning process will emphasize the use and development of higher level thinking skills. This includes creative thinking and problem solving (Kanevsky, 2016). Although many view creativity and critical thinking as opposite forms of thought, the first unteachable and the second teachable, these abilities are highly related. When students develop their critical capacities, or the ongoing critique of one creation, they also develop their creative capacities, the intellectual making of things. When students develop their creative capacities, they also develop their critical capacities. The two processes are best understood as two sides of the same coin, developing simultaneously as they enhance one another (Elder & Paul, 2006).

When forming an appropriate perspective of creative or complex thinking, it is also essential to separate the terms *cognitive complexity* and *difficulty*. Webb (1997) described depth of knowledge (DOK) within an educational objective as cognitively complex, involving the numerous connections students make from prior knowledge to current knowledge using strategic and extended forms of thinking in order to produce an idea that is original and purposeful. Sousa (2001) defined complexity as the thought processes required to address a task. Complexity can be thought of as the difference between simple fact or formula recall and developing an original idea, process, or procedure. Creative thinking thrives in the complexity of a task, where learners utilize previous experiences combined with new information to form something truly original. Difficulty simply refers to the amount of work or effort a student must use to complete a task,

regardless of complexity. One could have a learning objective requiring extensive amounts of difficulty that is low in complexity/creative demand. Although complexity and difficulty are necessary components of curriculum, the depth of knowledge or complexity of a learning standard should be high if the curriculum is truly appropriate for the 21st century learner.

Complex thinking can be referred to as strategic thinking, which involves synthesis, intuition, and creativity (Mintzberg, 1994). Strategic thinking refers to a creative, divergent thought process (Heracleous, 1998). The purpose of strategic thinking is to discover novel, imaginative strategies which can rewrite rules of the competitive game and to envision potential futures significantly different from the present (Heracleous, 1998). Strategic thinking involves developing creative skills in problem solving, teamwork, critical thinking, and flexibility (Baloch & Inam, 2007).

Strategic thinking is a mindset that allows you to anticipate future events and issues, create alternative scenarios, understand your options, decide on your objectives, and determine the direction to achieve those objectives (Herrmann-Nehdi, 1998). Sloan (2006) views five personal attributes as critical in order to think strategically: (a) having imagination, (b) a broad perspective, (c) the ability to judge, (d) the ability to deal with things over which you have no control, and (e) an adamant desire to win. Strategic thinking is a learnable skill benefitting from diverse experiences and open dialogue, requiring persistent practice to develop (Haycock, Cheadle, & Bluestone, 2012).

### **Problem Statement**

Developing complex thinking in students and exposing them to curricula that is rich in cognitive complexity has been deemed important for adequately equipping students to be college and career ready (e.g., Ernst & Young, 2010; IBM, 2012; World Economic Forum, 2015). The

existing literature on the topic of evaluating the cognitive complexity of specific learning strands found in the nationally implemented Common Core State Standards is limited. Although some studies have sought to assess the DOK levels of the CCSS (Florida State University, 2013), most fell short in assigning DOK levels to all standards and sub-standards. As the vendors of the CCSS and state education bureaucrats, including those in New Jersey, have made claims that these standards produce the creativity and critical thinking much needed in today's generation of students (CCSS Initiative, 2017), these claims must be tested for validity and legitimacy.

Many states, including the state of New Jersey, adopted and invested in the CCSS, which makes up the vast majority of standards in the New Jersey Student Learning Standards. Therefore, it is imperative that these particular standards be analyzed thoroughly to ensure that the NJSLS is truly advanced in cognitive complexity compared to other past curriculum standards such as the New Jersey Core Curriculum Content Standards, thus producing students who are better creative thinkers and problem solvers. Knowing the cognitive complexity found in the NJSLS and NJCCCS would enable educational policymakers, school administrators, and community stakeholders to make more informed decisions on the proper curricula to adopt at the local levels that would most benefit students in becoming college and career ready. No empirical evidence currently exists regarding the DOK levels of the NJSLS in Grades 6–8 compared to the DOK levels contained in the NJCCCS at these same grade levels. As the NJCCCS has been replaced by the NJSLS due to the claims of superior complexity and critical thinking for New Jersey's students, it is essential that these claims be affirmed or denied to ensure that our students are truly given the necessary tools for success in an increasingly complex, globally competitive economy.

### **Purpose of the Study**

My purpose for this qualitative content analysis study was to describe and compare the distribution of cognitive complexity within the mathematics New Jersey Student Learning Standards (NJSLS) and the New Jersey Core Curriculum Content Standards (NJCCCS) in Grades 6–8. Only the mathematics standards were the focus for this qualitative content analysis study. The middle school NJSLS was selected for this study due to the lack of research and analysis at the sixth to eighth grade levels.

### **Research Questions**

1. To what extent is cognitive complexity, as defined by Webb’s depth of knowledge, embedded in the New Jersey Student Learning Standards for Mathematics, Grades 6–8?
2. To what extent is cognitive complexity, as defined by Webb’s depth of knowledge, embedded in the New Jersey Core Curriculum Content Standards for Mathematics, Grades 6–8?
3. What differences and similarities exist in cognitive complexity between the New Jersey Student Learning Standards and New Jersey Core Curriculum Content Standards in Mathematics for Grades 6–8?

### **Conceptual Framework**

Webb’s depth of knowledge (Webb et al., 2005) was utilized as the conceptual framework for this study. Webb’s DOK consists of four levels of knowledge including Level 1, recall, and Level 2, skills and concepts. These particular levels require basic knowledge recitation and comprehension. No complex thinking is present in DOK Levels 1 and 2. Webb’s depth-of-knowledge Level 3, strategic thinking and complex reasoning, as well as Level 4,

extended levels of thinking, require students to reach deeper and think analytically and strategically. It is at DOK Levels 3 and 4 where researchers argue that complex thinking begins. This is in contrast to DOK Levels 1 and 2 that do not require this depth of thought. Being that the NJSLS have been adopted by the New Jersey State Board of Education, it is vital that these same standards are evaluated utilizing Webb's DOK levels to ensure that these standards include complexity, requiring high levels of complex thinking skills.

### **Significance of the Study**

There have been previous studies that used Webb's framework to measure depth of knowledge of the Common Core State Standards. For example, Florida State University's CPALMS (2013) study measured the DOK of the CCSS but gave a DOK rating to each standard as a whole and not the specific sub-standards. This study expanded the findings of previous studies by not only including all mathematics CCSS anchor standards for Grades 6–8, but also including the sub-standards or specific learning objectives embedded within each standard. There are no current studies at these grade levels that have addressed the specific focus of comparing the cognitive complexity of the NJSLS and a state's previous education standards in the NJCCCS. This analysis sought to add to the literature by using DOK as a way to measure complex thinking for each standard objective as well as assessing whether the claims made by the architects of the CCSS/NJSLS being rich in higher order thinking skills and cognitive complexity are indeed true.

Determining the complex thinking embedded in the NJSLS allows teachers, school administrators, and policymakers to ensure that students are being trained in the 21st century skills necessary for higher education and beyond. If complex thinking is not built into the NJSLS, these same stakeholders must take the necessary steps to evaluate and revise the current

learning standards to include these vital skills. In addition, if complexity is not consistently found in the learning standards, schools could be forced to allocate funds to purchase supplemental products that address such skills (Tienken & Orlich, 2013). As many questions remain regarding the validity of the NJSLS and gaps in literature exist in the comparing of the creative potential of these standards, this study sought to reveal the true cognitive demand of the NJSLS at the Grades 6–8 levels and determine if this set of learning standards measures up to the 21st century skills students need to succeed in today’s complex economy.

### **Study Design: Methodology**

Webb’s Alignment Tool (Webb et al., 2005) has been used as a framework to align standards with assessments and has earned national and international recognition. This tool can also be used to code and analyze curriculum standards based on their complexity levels and has been utilized as the framework for several related studies (CPALMS, 2013; Niebling, 2012; Sato, Lagunoff, & Worth, 2011; Sforza, 2014). Webb defines four levels of cognitive complexity as depth-of-knowledge (DOK) levels, which include recall and reproduction, skill and concepts, strategic thinking, and extended thinking. It is understood that the higher the DOK level of the standard, the higher the complexity and creativity required for that specific task/skill. In this study, Webb’s DOK was used to systematically analyze the cognitive demands of both the NJSLS and the replaced NJCCCS and gauge the complex thinking that each mathematics standard requires. The objective of this study was to assess the depth of the clues embedded in the language of the standard in order to determine if each standard helps a student develop creative and original thought. A curriculum that is low in complexity and depth of knowledge will not adequately prepare students to develop essential 21st century skills that lead to creative

and original thought (Gardiner, 1972). Relatedly, a curriculum high in complexity and depth of knowledge will enhance a student's creative abilities and deeper levels of thinking.

This study used a qualitative case study design with content analysis methods to describe and compare the percentages of the New Jersey Student Learning Standards and of the former New Jersey Core Curriculum Content Standards in Grades 6–8 mathematics that require students to demonstrate strategic and/or creative thinking. Qualitative content analysis is defined as an approach of empirical, methodological controlled analysis of texts within their context of communication, following content analytical rules and step-by-step models, without rash quantification (Mayring, 2000). Hsieh and Shannon (2005) defined qualitative content analysis as research methods for interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns. Utilizing Mayring's step model to guide analysis, this study sought to code and compare the various DOK levels of each Grade 6–8 mathematics standard and subsequent sub-standards of both the NJSLs and NJCCCS in order to draw important comparisons and conclusions.

### **Limitations of the Study**

Several limitations should be noted regarding this study. Although three coders were trained using Webb's DOK coding protocol, the results were based on the coders' experience and expertise. In addition, this study deviated from Webb's recommendation of using at least five coders. Three coders were utilized to increase efficiency and consistency, as a larger number of participants may detract from this goal. Furthermore, utilizing three coders for this study expanded upon other related studies that utilized only two coders.

This study was also limited to only the middle school grade levels of Grades 6–8 due to the lack of empirical evidence found at these levels. Also, the results of this study were limited to



the instrument, Webb's DOK framework, as no additional frameworks were utilized to conduct this research. Another limitation of this study was my decision to only analyze the standards and sub-standards in the Grades 6–8 Math NJSLS and NJCCCS. No other grade level learning standards, subject area standards, or state standards were analyzed in my study. My study was also limited to comparing the cognitive complexity within the NJSLS to the previous learning standards of only one state, New Jersey. Finally, this study did not assess the quality of the specific learning standards, as the focus was to determine only the complexity levels found within each set of learning standards.

### **Definitions of Terms**

*Cognitive complexity* refers to the cognitive demand associated with a particular learning standard or task based on Norman L. Webb's depth-of-knowledge (DOK) levels (Webb et al., 2005).

*Common Core State Standards (CCSS)* define what students are expected to know and be able to do. The CCSS are organized by grade level and subject area and were adopted by the state of New Jersey in 2010 (CCSS Initiative, 2017).

*Webb's depth of knowledge* (Webb et al., 2005) provides a vocabulary and a frame of reference when thinking about students and how they engage with the content. DOK offers a common language to understand "rigor," or cognitive demand, in assessments, as well as curricular units, lessons, and tasks. Webb developed four DOK levels that grow in cognitive complexity and provide educators a lens on creating more cognitively engaging and challenging tasks.

*The New Jersey Core Curriculum Content Standards (NJCCCS)* were created by the New Jersey State Board of Education in 1996 as the framework for education in New Jersey's public

schools and clearly define what all students should know and be able to accomplish at the end of 13 years of public education. These standards were replaced by the CCSS in 2010 (NJDOE, 2017).

*The New Jersey Student Learning Standards (NJSLS)* were adopted by the New Jersey State Board of Education in 2016 to replace the CCSS. These standards define what students are expected to know and be able to do (NJDOE, 2017). The NJSLS are organized by grade level and subject area and are documented as being vastly similar to the CCSS.

## **Chapter II**

### **Review of the Literature**

#### **Introduction**

My purpose for this qualitative content analysis study was to describe and compare the distribution of cognitive complexity within the Mathematics New Jersey Student Learning Standards (NJSLS) and the New Jersey Core Curriculum Content Standards (NJCCCS) in Grades 6–8. I selected the middle school NJSLS for this study due to the lack of research and analysis at the sixth to eighth grade level. With the need for an educated workforce of complex thinkers and problem solvers, assessing student learning standards to determine the amount of complex thinking is a potentially important endeavor. Supporters of the CCSS and NJSLS have made claims that the NJSLS produce the strategic and critical thinking needed in today's generation of students (Common Core State Standards Initiative, 2017). Such claims must be tested in order to ensure that all students in New Jersey receive the skills promised. This literature review identified existing empirical studies on the CCSS research on the theories of complex thinking, the analysis of complex thinking in state mandated curriculum standards, and frameworks that related to coding learning standards.

#### **Literature Search Procedures**

The peer-reviewed literature gathered for this review was found utilizing multiple online databases including ERIC, SAGE, and EBSCO. Each component was individually searched for using key words such as *CCSS*, *NJSLS*, *Webb's depth of knowledge*, and *complex thinking*. In some cases, specific works were sought due to their importance in other related studies. Non-peer-reviewed literature was also gathered from searching key terms and studies specifically

related to a set of skills most commonly termed 21st century skills. The aforementioned terms were searched utilizing the search engine Google.

### **Overview of Current Literature**

The research in the area of assessing curriculum standards, such as the NJSLs and NJCCCS, for complex thinking revealed two main findings. First, the literature gathered on complex, higher order thinking resulted in a plethora of peer-reviewed literature. Much of the literature (Barrington, Casner-Lotto, & Partnership for 21st Century Skills, 2016; Hunter, 1991; Kyllonen, 2012; Tan, 2015) expressed the need for complex thinkers and problem solvers in the workplace. There exists a common theme in the empirical literature that public schools in the U.S. have a responsibility to provide this type of training. The second part of the literature review included studies of the cognitive complexity of the CCSS and comparisons of the cognitive complexity of the CCSS high school standards in Mathematics and English Language Arts and the previous high school New Jersey Core Curriculum Content Standards in those subjects using Webb's depth of knowledge. Although several studies were found that categorized the cognitive complexity of the CCSS, only one study was found that examined the New Jersey standards (Sforza, 2014). Only a select few studies (CPALMS, 2012; Niebling, 2012; Sforza, 2014) contained similar methodologies and focus to the one I conducted.

This literature review was limited to an overview of the subcategories under complex thinking: (a) creativity, (b) strategic thinking, and (c) critical thinking. The literature reviewed in these sections coalesced into two categories including peer-reviewed and non-peer-reviewed including think tanks and governmental reports. In the circumstance that only peer-reviewed literature was reviewed, the non-peer-reviewed subheading was eliminated.

## **Methodological Issues With Existing Literature**

There were various issues regarding the existing empirical research on complex thinking, 21st century skills, and the coding of the NJSL and NJCCCS. First, the variation of terms relating to complex thinking made it difficult to navigate through research results. In addition, definitions of terms such as complex thinking, creativity, strategic thinking, and critical thinking were often interwoven and blurred. It was one aim of this review to clarify these terms and show their interconnectedness at the same time. Another issue found in the empirical research on the coding of specific standards involved the methodology of their coding procedures. Some studies only involved Grades 9–12 in their review, while others coded only the major standards of the similar CCSS, excluding the sub-standards attached to that major standard.

## **Inclusion Criteria**

Research used in this review included:

1. studies including the coding of specific learning standards,
2. peer-reviewed research including dissertations and government reports,
3. non-peer reviewed surveys of skills desired by multinational corporations,
4. studies that focused on complex thinking,
5. dissertations,
6. reports from think tanks and private foundations,
7. peer- and non-peer-reviewed literature about the Common Core State Standards,
8. frameworks utilized to assess learning standards/student learning, and
9. Studies published within the last 50 years.

## 21st Century Skills

### Non-Peer-Reviewed

From the non-peer-reviewed literature, the term *21st century skills* encompasses a broad spectrum of skills, perspectives, capabilities, dispositions, and competencies that will evolve further with continued changes in technology and culture. The Partnership for 21st Century Skills (P21), founded in 2002 by Ken Kay and Diny Golder-Dardi attempted to clarify 21st century skills. P21 proposed a set of 21st century student outcomes, including academic achievement in core subjects (the 3 Rs) and the four Cs such as critical thinking, communication, collaboration, and creativity (Kyllonen, 2012, p. 6). The 21st century skills promoted by P21 emphasized what students should be able to do with knowledge, rather than what knowledge they have (Silva, 2009). The concept of 21st century skills conveys the idea that changes in technology and culture are leading to changing demands in the workplace, so the skills that are required in today's and the future workplace are different from those required in the past. If the requirements of the 21st century workplace are changing, there may be increased pressures on the educational system to produce the skills that are emerging in importance (Kyllonen, 2012, p. 4).

In a recent report titled, *Are They Really Ready to Work?* four participating organizations jointly surveyed over 400 employers across the United States (Barrington et al. 2006). The employers were asked to articulate the skill sets that recently hired graduates from high school, two-year colleges or technical schools, and four-year colleges need to succeed in the workplace. Approximately 74% percent of respondents expected creativity and innovation to increase in importance for future workforce entrants. In this same study, 54.2% of employer respondents reported that they viewed the current new workforce entrants as deficient in this specific skill set

(Barrington et al. 2006, p. 10). The largest multinational corporations will be looking for the most competent, most creative people and are willing to pay top dollar for their services (CISCO Systems, 2008). Some commentators suggest that creativity is an essential 21st century skill, and college students, workers, and citizens must be able to solve multifaceted problems by thinking creatively and generating original ideas from multiple sources of information (Silva, 2009, p. 1).

The skills and dispositions of creativity, innovation, and adaptability are the hallmarks of competitive, high growth industries that require a highly skilled, creative, and nimble workforce (Ewing Marion Kauffman Foundation, 2007). Innovation is a key driver of competitiveness, job growth, and a higher standard of living for future generations (U.S. Department of Commerce, 2012, p. 2-1). The competitiveness of a country and the competitiveness of businesses are said to be closely linked concepts. Competitive businesses need to innovate; otherwise, they will not be able to grow and remain viable (U.S. Department of Commerce, 2012, p. 2-3). For some businesses to be innovative, they will need a creative, innovative workforce.

### **Peer-Reviewed**

Proponents of 21st century skills point to a new workforce reality that demands a next generation of college students and workers who are independent thinkers, problem solvers, and decision makers (Silva, 2009). Skills and dispositions such as self-direction, creativity, critical thinking, and innovation are newly relevant in an age where complex thinkers are in high demand (Soulé & Warrick, 2015; Tienken, 2016). For the purpose of this study, 21st century skills were defined as the specific competencies and dispositions that go beyond content knowledge that are necessary for students to become complex thinkers, prepared to compete in a globally competitive economy. Twenty-first century skills definitions focus on similar types of complex thinking, learning, and communication skills. These abilities are also commonly

referred to as higher order thinking skills, deeper learning outcomes, and complex thinking and communication skills (Saavedra & Opfer, 2012). Twenty-first century students entering the workforce need the desire and the ability to think, to gather data, to formulate models, to test hypotheses, and to reason to conclusions (Posner, 2002).

The need for developing creative innovators in our nation's schools is also economic in nature. With increased competition from foreign corporations and governments, the role of creativity in the economy is being seen as crucial for attaining higher employment and achievement (Burnard, 2006). Formal education has been criticized for turning out "conformists" rather than freely creative and original thinkers (Rogers, 1970). Zhao (2012) stated that schools in general reduce creative thinking instead of enhance creativity and the entrepreneurial spirit because public school policy is designed to prepare good employees. There is some consensus that education policy in the U.S. is failing to adequately provide for the preparation of all students with the essential 21st century knowledge and skills to succeed in school, career, life, and citizenship (Soulé & Warrick, 2015, p. 1; Tienken, 2016; Zhao, 2012). Education systems are being required to undergo a major overhaul in resources, attitude, and understanding so that creativity can be valued (Turner-Bisset, 2007).

Schools are being seen as places for the encouragement of creativity because they serve the masses and offer tremendous opportunities for skill development. Curricula that are linked to inquiry learning are the key to creativity. Students can generate their own questions through inquiry learning and develop critical thinking skills (Longo, 2010, p. 56). Advocates of 21st century skills favor student-centered methods such as problem-based learning and project-based learning, which allow students to collaborate, work on authentic problems, and engage in the community (Rotherham & Willingham, 2010, p. 17). This is much aligned with the theoretical



approach of humanistic education. Humanistic educators believe that meaning is discovered through relating events to the self and that long-lasting learning takes place when knowledge is connected to the affected state of the learner. Learning is viewed as an active process that necessitates involvement and participation. Humanistic educators focus on creating changes in perception rather than an accumulation of facts (Bell & Schniedewind, 1989, pp. 202–203). Like intelligence and learning capacity, creativity is not a fixed characteristic that people either have or do not have; rather, people can learn to be more creative (Saavedra & Opfer, 2012). Students must leave school with a deep knowledge of academic content, and with the 21st century skills they need to apply their knowledge, work with others, and manage their lives as this is at the heart of a quality education (Kay, 2009).

### **Higher Order Thinking**

#### **Peer-Reviewed**

The seemingly ever-changing world of work requires students to go beyond collecting and storing factual knowledge; today's students need to develop their complex or higher order thinking skills to compete globally (Miri, David, & Uri, 2007). Hunter (1991) found the following:

All academic disciplines must accept the responsibility and accountability of exposing our students to and training them in the basic higher order thinking skills that will provide them with the cognitive processes to confront a rapidly changing world and to be free to explore the unknown future. (p. 74)

The current generation needs a more meticulous education because information, which rapidly increases and changes both in technological and in socio-cultural content, is extremely complex (Lee, 2007). Levin (as cited in Seymour, 2004) suggests that in order to effectively prepare

students to successfully engage with their environment, we must improve students' higher order thinking skills. As predicting the future needs of society is difficult, the teaching of complex thinking should involve engaging students in what we predict will be challenging problems, guiding their manipulation of information to solve them, and supporting their efforts as all learners can participate in higher order thought (Newmann, 1988; Tienken, 2016). As we are certain to encounter change in the 21st century, successful adaptation to this change will require that teachers and students increase their inclination and ability to use different types of higher level thinking (Geertsen, 2003). Higher order and creative thinking aligns with the views of the humanist educators who have voiced compelling rationales for change in the direction of teacher education, wishing to break the pattern of programmed instruction that can smother individual differences (Cohen & Hersch, 1972, p. 173). Unlike behaviorists, who regard people as governed by stimuli from the external environment, humanists view individuals as a source of their own actions, encouraging free choice instead of determinism (Bell & Schniedewind, 1989, p. 202).

Complex or higher order thinking can be defined in many ways including simply as those skills that require any thinking above factual recall, literal comprehension, or imitative application of procedures (Cross & Nagle, 1969). Higher order thinking signifies challenge and expanded use of the mind as opposed to lower level thinking, which only includes routine, mechanistic application of the mind (Newmann, 1988). Geertsen (2003) defined higher order skills as a disciplined, systematic way of using the mind to confirm existing information or to search for new information.

Higher order thinking occurs when a person takes new information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations (Lewis & Smith, 1993). Higher order thinking can be

conceptualized as a non-algorithmic, complex mode of thinking that often generates multiple solutions. Utilizing Bloom’s taxonomy to compare levels of thinking, this complex thinking overlaps with the higher levels of analysis, evaluation, and synthesis (as cited in Miri et al., 2007).

Newman (1990) developed a distinction between lower and higher order thinking, concluding that lower order thinking demands only routine or mechanical application of previously acquired information such as listing information previously memorized and inserting numbers into previously learned formulas. In contrast, Newmann (1990) viewed higher order thinking as thinking that requires the student to interpret, analyze, or manipulate information. Newmann’s (1990) definition of higher order thinking skills is also similar to that of Lewis and Smith (1993). “Higher order thinking occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations” (p. 136). Geertsen (2003) identifies six dimensions to higher order thinking (See Figure 1).

Six Dimensions	Twelve Types of Higher Level Thinking	
Strategic Thinking	Decision Making	Problem Solving
Referential Thinking	Conceptualizing	Contextualizing
Assessment Thinking	Critical Judging	Dimensionalized Judging
Scientific Thinking	Researching	Theory Building
Reflective Thinking	Foundational	Constructional
Comparative Thinking	Typological	Analogical
	↑ Critical Thinking	↑ Reflective Thinking

*Figure 1.* Geertsen’s six dimensions of higher order thinking.

For the context of this study, complex thinking is defined as the ability to creatively and/or strategically apply information to identify and solve a problem or construct an original idea in order to solve a problem or task in a creative and authentic way.

A complex thinker can identify a problem, state alternative solutions, offer evidence, judge logical consistency, detect bias, and find new sources of information (Newmann, 1988). A variety of purposes can be achieved through higher order thinking including: deciding what to believe, deciding what to do, creating a new idea, creating a new object, creating an artistic expression, making a prediction, and solving a non-routine problem (Lewis & Smith, 1993). Higher order thinking skills enable students to see concepts holistically and influence the attitude of these deeper thinkers (Shukla & Dungsungnoen, 2016). Glaser (1985) identified three elements of higher order thinking including the knowledge of thinking strategies, skill in applying those strategies, and a proper attitude or disposition toward thoughtful and perceptive consideration of most problems within the range of personal experience. From elementary school and up, students must select, interpret, internalize, assess, learn, and apply knowledge, so that it is difficult to imagine academic content where thinking skills are not relevant (Lizarraga, Baquedano, & Oliver, 2010).

Teaching higher order thinking skills requires time, training, and focus. These skills can be facilitated in two contexts, where the thought process is needed to solve problems, create solutions, and make decisions in creative and original ways and where mental processes are needed to benefit from instruction involving comparing, evaluating, justifying, and making inferences (Wheeler & Haertel, 1993). Shukla and Dungsungnoen (2016) state that teaching higher order thinking skills occurs when students:

- visualize a program by diagramming it

- separate relevant from irrelevant information in a word problem,
- seek reason and causes,
- justify solutions,
- see more than one side of a problem,
- weigh sources of information based on their credibility,
- reveal assumptions in reasoning, and
- identify bias or logical inconsistencies.

Developing the complex or higher order thinking of students includes several skills under the umbrella of complex thinking such as creativity, critical thinking, and strategic thinking.

### **Creativity**

**Peer-Reviewed.** Azzam (2009) suggested that creativity has been ignored and neglected historically but is finally showing its importance. Despite it being an abstract term utilized in several contexts, creativity has been identified as an essential 21st century skill for all students (Hammershøj, 2013). Researchers have generated several descriptions of creative thinking. Carruthers (2002) suggested that thinking creatively is imagining things differently than how they currently are. Lin (2010) described creativity in terms of imagination, independent thinking, and risk taking. Runco (2008) defined creativity simply as “thinking or problem solving that involves the construction of new meaning” (p. 96). Although creativity in people is innate, it needs to be cultivated and nurtured.

Cognitively, creative people have been described as (a) being able to think metaphorically and flexibly, (b) independent in judgment, (c) skilled in decision making, (d) able to cope well with novelty and ambiguity, (e) willing to take risks, (f) able to visualize and play with ideas internally, (g) able to break away from set ways of thinking, (h) question norms and

assumptions, and (i) are alert to novelty and gaps in knowledge (Tan, 2015, p. 163). Sternberg (2006) described the investment theory of creativity as the ability of creative people to buy low and sell high in the realm of ideas. Buying low means pursuing ideas that are unknown or out of favor but have growth potential. These ideas when presented often encounter resistance. The creative individual perseveres and eventually sells high, moving on to the next new or unpopular idea.

Against some popular views, creativity is something that can be found in every child, not just the elite. Glaveanu (2011) states that all young students are active, interactive, and creative individuals whose creativity can be fostered. Providing experiences in which students can use their imaginations, play with and develop ideas, and reflect on the processes and outcomes is necessary but not easy (Newton & Newton, 2014, p. 578). Based on the extant literature, I defined creativity as an individual's ability to design unique solutions or apply processes in original ways.

Creativity can help people develop their problem-solving and other thinking skills, enrich their lives and develop a capacity to cope, develop, and grow in response to change in their own society (Newton & Newton, 2014, p. 578). Due to the accelerated pace of evolving technology, 21st century learners increasingly require the ability to adapt, innovate, and problem solve. Beghetto (2007) argues that creativity is the ultimate resource and an essential for addressing complex individual and societal issues. Fundamental changes in the economy, jobs, and businesses are driving new, different skill demands. Today, more than ever, individuals must be able to perform non-routine, creative tasks if they are to succeed (Soulé & Warrick, 2015, p. 180). The educational system of today has to prepare the next generation for the reality of the future. It will be increasingly important for the next generation to be creative, and that makes the

cultivation of creativity on all levels of the educational system a matter of urgency (Hammershøj, 2013, p. 181).

Given such importance, public school personnel are charged with the responsibility of graduating students who are creative thinkers and problem solvers, who are ready to contribute positively to society. This was advocated early on in the *Cardinal Principles of Secondary Education* (Commission on the Reorganization of Secondary Education, 1918). The authors declared that education in a democracy should develop in each individual the knowledge, interests, ideals, habits, and powers whereby he will find his place and use that place to shape both himself and society toward ever nobler ends (Commission on the Reorganization of Secondary Education, 1918, p. 4).

Fostering creativity is not a part of a curriculum but rather a whole curricular approach that is woven throughout all learning experiences that a school provides. Teachers can and should provide an environment in which they encourage, nurture, support, and value creativity while encouraging students to think differently and explore alternative possibilities (Newton & Newton, 2014, p. 580). Creative and critical thinking should be embedded into our academics, which, when combined with academic rigor, will formulate an effective 21st century curriculum that truly prepares students for college, careers, and society as a whole.

## **Strategic Thinking**

**Peer-Reviewed.** Strategic thinking is another element of complex thinking. Strategic thinking is a particular way of thinking, with specific attributes. These attributes include a systems perspective, intent focused, thinking in time, hypothesis driven, and intelligent opportunism (Liedtka, 1998). The strategic thinker sees linkages within the system from multiple perspectives. Strategic thinking is a flexible means of solving strategic problems and

conceptualizing the future (O'Shannassy, 1999). Strategic thinking involves developing creative skills in problem solving, teamwork, critical thinking, and flexibility (Baloch & Inam, 2007).

The purpose of strategic thinking is to discover novel and imaginative strategies that can rewrite the rules of the competitive game and to envision potential futures significantly different from the present (Heracleous, 1998). The process toward which we move into that future is experimental and makes use of our best creative thinking to design options and to test them (Liedtka, 1998). Strategic thinking is a mindset that allows one to anticipate future events and issues, create alternative scenarios, understand your options, decide on your objectives, and determine the direction to achieve those objectives (Herrmann-Nedhi, 1998). In this view, strategic thinking requires an approach that anticipates rather than reacts.

Haycock et al. (2012) defined strategic thinking as thinking that is an innovative, creative, and right-brained process that encourages the exchange of ideas and is a learnable skill requiring persistent practice to develop. Continuous application and repetition improves strategic planning in students and develops the attributes required for success. Sloan (2006) views five personal attributes as critical in order to think strategically, including having an imagination, a broad perspective, the ability to juggle, the ability to deal with things over which you have no control, and an adamant desire to win. In the context of this study, strategic thinking is being defined as thinking that is purposeful and complex, resulting in a systematic understanding of a problem and its solution.

### **Critical Thinking**

**Peer-Reviewed.** The globalized economy requires students to go beyond the building of their knowledge capacity; they need to develop their higher order thinking skills, such as critical thinking, decision-making, and problem solving (Miri et al., 2007). The development of critical



thinking is widely considered a worthy educational goal, with recognition of its importance increasing in recent years (Kettler, 2014). Critical thinking skills can lead to an engaged citizenry by supporting learners as they practice analyzing issues, applying evidence, framing problems, questioning assumptions, and identifying relevant contexts needed for a solution (Rhodes, 2010).

John Dewey (1933) was one of the first educators to distinguish between levels of thinking as he described critical thinking as the judgments that an individual made while solving a problem. Critical thinking refers to students constructing arguments, applying logic to reasoning, and providing evidence to support their inferences (Young, 1992). Critical thinking has also been defined as purposeful reflecting and reasoning about what to do or believe when confronting complex issues, taking into account relevant contexts (Ennis, 1987). Lewis and Smith (1993) assign three distinct meanings to critical thinking including (a) critical thinking as problem solving, (b) critical thinking as evaluation or judgment, and (c) critical thinking as a combination of evaluation and problem solving. Definitions of critical thinking also include a skill component involving the ability to interpret, analyze, evaluate, and infer even when meanings and significance are not apparent (Abrami et al., 2015). The application of critical thinking is associated with several elements of reasoning including: purpose of thinking, key issues or questions being considered, assumptions, point of view, evidence, concepts and ideas, inferences or interpretations, and implications or consequences (Celuch & Slama, 1999). For the purpose of this study, critical thinking is being defined from the extant literature as the divergent application of information and prior knowledge in the construction of new ideas, thoughts, opinions, or solutions.

Critical thinking capabilities can be divided into two categories (a) skills – the ability to analyze, evaluate, and make inferences, and (b) disposition – the motivation, inclination and

drive of the learner to immerse himself/herself in deep thinking while making decisions or problem solving (Facione, Facione, & Giancarlo, 1996). The improvement of critical thinking skills that comes from self-evaluation is helpful in developing a number of valuable intellectual traits including intellectual humility, intellectual empathy, intellectual courage, intellectual integrity, and intellectual perseverance (Celuch & Slama, 1999). Students must have the skills to respond to their rapidly changing and increasingly complex environments. It is also understood that these problem-solving abilities can be taught and that higher order thinking skills can be affected by instruction (Young, 1992). Teaching students various types of reasoning skills, such as inductive and deductive reasoning, appropriate to a given situation equips students to reason effectively (Donovan, Green, & Mason, 2014).

### **The Common Core State Standards**

The Common Core State Standards (CCSS) is a set of K–12 curriculum standards in mathematics and English language arts/literacy (ELA). These curriculum standards define learning expectations for what a student should know and be able to do at the end of each grade level. The creators of the Common Core, the National Governors Association and the Council of Chief State School Officers, claim (Common Core State Standards Initiative, 2017) that the standards were created to ensure that all students graduate from high school with the skills and knowledge necessary to succeed in college, career, and life, regardless of where they live. Supporters of the CCSS have stated that the Common Core not only helps students acquire the skills for success in life after high school but additionally offer consistency in a student's educational journey and let employers know what to expect from high school graduates (Gardner & Powell, 2014). Forty-two states, the District of Columbia, four territories, and the Department of Defense Education Activity (DoDEA) have voluntarily adopted and are moving forward with

the Common Core. Seeking to form consistent learning goals across states, the state school chiefs and governors that comprise CCSSO and the NGA Center coordinated a state-led effort to develop the Common Core State Standards (Common Core State Standards Initiative, 2017).

The CCSS effort was influenced in part by several larger for-profit/non-profit organizations such as the Center for American Progress, the Thomas B. Fordham Foundation, the Alliance for Excellent Education, and the Bill and Melinda Gates Foundation (McDonnell, 2012, p. 181). Large financial support for the standards was also given by the Bill and Melinda Gates Foundation. Between 2009 and 2011, the Gates foundation invested \$76 million in designing instructional tools for teachers to use in implementing the mathematics and ELA standards and in assisting state agencies and local districts in their CCSS efforts (Phillips & Wong, 2012). The standards attempt to provide a clear and consistent framework for educators on a national scale.

In 1996, New Jersey adopted its first state curriculum standards in nine subject areas, known as the Core Curriculum Content Standards (NJCCCS). The New Jersey State Board of Education voluntarily adopted the Common Core State Standards in 2010 to replace the previous English language arts and mathematics standards (NJDOE, 2017). These standards define what students from kindergarten through high school are expected to know and be able to do. These standards are not a curriculum, and local school districts have the responsibility to develop their own curricula that will assist teachers in ensuring that students meet each standard unless a school district is under a mandate to use the New Jersey Model Curriculum, which is simply a copy of the CCSS and NJSLS. Instructors have the license to fashion curriculum activities and instruction that are both Common Core aligned and responsive to local needs, but they must address the specific standards (Peery, 2013, p. 3).

Advocates for the Common Core State Standards claim that the standards provide a framework for higher level skill development than has been the case with earlier state standards and require students to produce evidence of learning through products that emphasize the use of higher level thinking skills (VanTassel-Baska, 2015, p. 60). Supporters and vendors of the Common Core claim the standards focus on skills not texts and methods that must be utilized to teach the skills. According to Gardner and Powell (2014), these standards offer a clear framework of what students should be able to do (the skills). These skills are placed at a higher precedence than even the content being studied (p. 50).

Advocates also state that the CCSS correlate well with 21st century requirements for world learning and testing while emphasizing the knowledge and skills necessary for working in modern-day careers (VanTassel-Baska, 2015, p. 61). The claim made by supporters of the CCSS is that the CCSS are designed to prepare students to critically analyze information and events and become problem solvers, precisely what life in this global and technological age will require of them (March & Peters, 2015). “The Common Core State Standards mean increased rigor. Making sure students have refined the thinking skills that will serve them in other classes and after high school is a far cry from helping students ace multiple-choice tests” (Gardner & Powell, 2014, p. 50).

Proponents of the CCSS initiative also state that the CCSS provides a common base for learning at the national level, a standardized approach in ensuring that all students are college and career ready by mastering the complex, higher order thinking so desperately needed. “The Common Core integrates multiple skills and requires analytic and critical thinking. Students are expected to drill down into the deep structure of documents and problems and to identify connections among facts and ideas” (March & Peters, 2015, p. 64). As proclaimed by the

Common Core State Standards Initiative (2016), the Common Core focuses on developing the critical-thinking, problem-solving, and analytical skills students will need to be successful.

Critics of the Common Core State Standards present their arguments from several angles. Although the CCSS formation and adoption is presented as a collaborative process, critics state that this was a “behind closed doors” process that only involved certain policy entrepreneurs and private Washington-based organizations, organizations that stand to make money from these national standards and testing (Tienken & Zhao, 2010, p. 8). Once created, states were coerced to adopt the new standards as a requirement for applying for a piece of the Race to the Top Fund, a \$4.35 billion slice of President Obama’s American Recovery and Reinvestment Act. Only states that adopted the standards had a chance to win Race to the Top Funds (Toscano, 2013, p. 414). The adoption of the CCSS also gave reprieve to states from certain restrictions imposed under the 2001 No Child Left Behind legislation. Despite the CCSS being sold as an option, critics view the adoption of the CCSS as strictly a “top down” initiative with little choice left in the matter (Toscano, 2013).

Critics of the Common Core State Standards also view the CCSS as lacking true local control for schools. With an overemphasis of specific tested subjects over others, the curricula will become skewed towards those subjects purposefully or inadvertently. The curricula that schools will generate from here forward will be crafted to reflect their interpretations of the CCSS and not to reflect the desires of parents and local communicates (Toscano, 2013, p. 416). In addition, standardized curricula could lose valuable support as the process of choosing what students should learn is removed from local control. Tienken and Zhao (2010) stated that teachers who are forced to follow programmed or scripted programs do not create learning; they

merely imitate processes, that, in turn, results in loss of vital skills and learning experiences for students.

Another criticism of the Common Core State Standards is that the standards overemphasize specific disciplinary skills while not offering enough emphasis on creativity, problem-solving, and entrepreneurial activities. Under the CCSS, English Language Arts and Mathematics instruction becomes a sole focus for schools due to the accountability that is attached by standardized testing. Zhao (2012) calls this process curriculum narrowing, and this happens on two levels. First, when high stakes are attached to a limited number of subjects, they take precedence over other subjects. Second, schools tend to take a “teach to the test” approach that is far from ideal for young learners. The overarching goal of education in the U.S. should be to prepare people who can strategize, problem solve socially conscience issues, create, collaborate, and innovate. The standards themselves and the exams that accompany them have not been proven to be a catalyst for these vital skills (Tienken & Zhao, 2010, p. 4). In fact, some critics point out that the CCSS minimize subjects such as experience-rich reading to fact-finding and depersonalization (Sulzer, 2014, p. 135). The reader as a reflecting, active contributor of the reading process seems to have been removed.

Criticism of the CCSS can also be found in the creation and validity of the standards. Due to the political and monetary factors attached, states signed up in droves to implement the CCSS, although the standards have never been field-tested (Kern, 2014, p. 75). Little to no research has been completed to assess what positive or negative consequences result from implementing the specific standards in K–12 schools. Several states that had originally adopted the CCSS have since reconsidered and either abandoned, revised, or changed the name of these standards. On May 28, 2015, New Jersey’s Governor, Chris Christie, was one of the latest governors to

criticize the effectiveness of the CCSS and ordered a task force to investigate and revise the standards.

In a time where standardization and common learning experiences are overly emphasized, historical work with educational policy seems to suggest a very different approach. The authors (Commission on the Reorganization of Secondary Education, 1918) of the *Cardinal Principles of Secondary Education* called for educating all children through high school in an untracked, yet differentiated curricular program. The results of the Eight-Year Study (1942) demonstrated that public secondary schools can educate students together, differentiate instruction to meet unique needs, and diversify course offerings (Aikin, 1942). Operating schools in this nonstandardized way will produce better results and ultimately fulfill the role proposed by Thomas Jefferson and other defenders of a democratic, classless educational system (Tienken & Orlich, 2013).

This literature suggests a link between creativity and essential 21st century learning. The public school educational system should foster creative thinkers, innovators, and entrepreneurs that will successfully compete globally. Being college and career ready is an overarching goal for advocates of the Common Core State Standards, stating that the adoption of these rigorous standards are much improved over previous state standards. Critics of the standardization movement and the Common Core State Standards pose important questions regarding the CCSS to ensure that the direction in which educational policy makers are heading is indeed the right direction.

### **The New Jersey Student Learning Standards**

One year after Governor Christopher Christie declared that the Common Core Curriculum Standards were not working in New Jersey, the state has adopted a revised version of

the CCSS (New Jersey Department of Education, 2017). The State Board of Education on May 4, 2016, gave final approval to the New Jersey Student Learning Standards, which will outline what skills students should learn at each grade level. The New Jersey Student Learning Standards include Preschool Teaching and Learning Standards, as well as nine K–12 standards for the following content areas including: 21st Century Life and Careers, Comprehensive Health and Physical Education, Language Arts Literacy, Mathematics, Science, Social Studies, Technology, Visual and Performing Arts, and World Languages (New Jersey Department of Education, 2017). The new Language Arts and Mathematics standards will go into effect in New Jersey schools beginning in the 2017-18 school year.

The most recent review and revision of the state standards occurred in 2014. However, the CCSS aligned language arts and mathematics standards underwent an additional taskforce review in 2015. As such, New Jersey will maintain about 84% of the 1,427 Language Arts and Mathematics standards that make up the CCSS (Clark, 2016). "It won't be substantially different," said Mark Biedron, president of the state board. "We looked at everything to make sure that it was crystal clear, age appropriate. Yes, there were some changes, but there were not major changes." Speaking about the revised standards, state Education Commissioner David Hespe said, "I think I can safely say that New Jersey has the best standards in the country" (Clark, 2016, p. 1).

Despite the revisions to the CCSS, critics feel that not enough was in the revision of the New Jersey Student Learning Standards (NJSLS) to make them appropriate for 21st century learners. C. Tienken (personal communication, June 5, 2016) noted that the revisions to the mathematics standards focused mostly on adding examples and word choices with no substantial changes to the levels of complex thinking. The CCSS has been noted for containing lower levels



of complex thinking and cognitive complexity at the high school levels (Sforza, Tienken, & Kim, 2016), and no revisions were made to address this specific deficiency. C. Tienken (personal communication, June 5, 2016) also stated in his review of the NJSLs ELA standards, most of the revisions to the standards include the addition of only a few words. For example, the word *reflect* was added 16 times in the K–12 ELA standards. Although *reflect* could have been used to increase the complex thinking required of students, it was used in such general ways that it holds no instructional value for teachers. Although the taskforce set out to make the substantial changes as charged by Governor Christopher Christie, the New Jersey Student Learning Standards, although renamed, are strikingly similar to the original Common Core State Standards.

### **Related Studies**

Curriculum standards specify a set of expectations for students that can be charted against a child's age or progression through schooling. Curriculum standards can be the building blocks of curriculum, used to guide instructional goals and inform assessment. Curriculum standards provide the “what” of education, while instruction captures the “how” (Snow, 2015). With the importance of learning standards already established, many have set out to evaluate various standards utilizing Webb's DOK (Webb et al., 2005) levels to determine the complex thinking contained within those specific standards.

Sato et al.'s (2011) Smarter Balanced Assessment Consortium (SBAC) Study was a descriptive analysis of the Common Core State Standards. The learning standards analyzed were those in Grades 9 through 12 in Language Arts and all conceptual categories in mathematics contained in the CCSS. In this study, analysts reviewed each standard to determine the range of cognitive complexity required to perform the skill or demonstrate the knowledge described by

the standard and how well it aligned to questions on the SBAC. Webb (1997) described depth of knowledge within an educational objective as cognitively complex, involving the numerous connections students make from prior knowledge to current knowledge using strategic and extended forms of thinking in order to produce an idea that is original and purposeful (p.15).

Sato et al.'s (2011) study employed a double-rater "read behind" consensus model and involved ongoing calibration between analysts. For each grade level, one analyst independently coded the standards. A second analyst then reviewed the outcomes of the first analyst's ratings and noted agreement or disagreement with the first analyst's rating. The two analysts then discussed any discrepancies between their interpretations as necessary. Because some standards describe skills at multiple levels of complexity (e.g., when there are multiple skills in a standard that could be applied at different levels of complexity), analysts in this particular study indicated all applicable DOK levels contained in that standard.

The results of Sato et al.'s (2011) analysis revealed that the vast majority of CCSS learning standards in Language Arts fell within DOK Levels 2 and 3 while the vast majority of CCSS learning standards in Mathematics fell within DOK Levels 1 and 2. In review of this study, the strengths of this particular study are the incorporation of the read behind consensus model and precise coding protocol conducted in this research. The weaknesses of the Smarter Balanced study fall in the decision to code standards utilizing multiple DOK levels. Relatedly, the study coded only the macro standards as opposed to coding both the standards and sub-standards found in the CCSS with individual DOK ratings.

In Niebling's (2012) Cognitive Complexity Study, Webb's DOK framework was utilized to assign cognitive complexity/demand codes to the Iowa Core Standards and sub-standards. This study defined a rigorous and relevant curriculum as one that is cognitively demanding and

challenging to students as they apply the essential concepts and skills to real world, complex, and open-ended situations (p. 13). The Iowa Core curriculum alignment framework was also discussed. In this framework, curriculum is broken down into four categories: intended (i.e., what is supposed to be taught), enacted (i.e., what is actually taught), assessed (i.e., what is assessed), and learned (i.e., what is learned by students, as demonstrated through the assessed curriculum) (p. 11). Similar to Sato et al.'s (2011) study, Niebling also utilized the "read behind" consensus model to rate the Iowa Core learning standards utilizing Webb's DOK levels. The results of Niebling's analysis resulted in the vast majority of the Iowa Core Literacy Standards being coded as a Level 2 or 3, while the majority of the Iowa Core Mathematics Standards fell within DOK Levels 1 and 2 (Niebling, 2012). The strengths of this particular study involved the use of an effective coding agenda including team calibration and the scope of coding all of the Iowa K–12 language arts and mathematics standards and sub-standards. Similar to Sato et al., Niebling's study is weakened by the assigning of multiple DOK levels to the Iowa curriculum standards and sub-standards.

In another study, Florida State University's (2013) Collaborate, Plan, Align, Learn, Motivate, and Share (CPALMS) study evaluated the CCSS for cognitive complexity utilizing Webb's DOK (Webb et al., 2005) model of content complexity. Florida's original three-level model of low, moderate, and high DOK had been used since its implementation of new standards in 2004. However, adopting Webb's four-level DOK model results in a better ability to determine the level of complexity required in an individual standard. This study further explains that in contrast to cognitive complexity, content complexity relates specifically to the cognitive demands that can be inferred from the language of a content standard. Furthermore, content complexity considers factors such as prior knowledge, processing of concepts and skills,

sophistication, number of parts, and application of content structure required to meet an expectation or to attain an outcome (CPALMS, 2014).

CPALMS hosted a workshop in July of 2012 to determine the content complexity ratings for the ELA and math standards. A team of curriculum developers, researchers, subject-area experts, and teachers around the state were involved in this event. Professional development was provided to all participants by a team of leading experts including Dr. Norman Webb (Florida State University, 2013). A strength of the CPALMS study that differed from that of Sato et al.'s (2011) and Niebling's (2012) studies is that this analysis gave one DOK rating to each standard and sub-standard within the CCSS K–12 ELA and math curriculum standards. This approach offers much more precision than previous studies and is better aligned to Webb's et al.'s (2005) recommendations. A weakness of the CPALMS study is that these coding results were not compared to any other sets of curriculum standards.

Sforza et al.'s (2016) Cognitive Complexity study sought to examine the cognitive complexity of the nationally adopted Common Core State Standards in Grades 9–12 English language arts and math as compared to the cognitive complexity of the New Jersey Core Curriculum Content Standards in Grades 9–12 English language arts and math using Webb's depth-of-knowledge framework. Relatedly, the study aimed to reveal the extent to which 21st century skills, such as creativity, critical thinking, strategizing, and problem solving are infused into the Common Core standards as compared to the New Jersey Core Curriculum Content Standards.

In this qualitative content analysis study, Webb's DOK was utilized to code and compare both the CCSS and NJCCCS standards. Each depth-of-knowledge level represents a specific level of cognitive complexity, meaning the higher the DOK level of a standard, the more

cognitively complex in the standard. Each standard was rated on a 1–4 DOK level utilizing a double-rater read behind consensus model to provide reliability during analysis. The strengths of Sforza et al.’s (2016) study were an organized coding agenda, team calibration, and the coding and comparison of two sets of curriculum standards and sub-standards. The weakness of this study is that Sforza et al. deviated from Webb et al.’s (2005) recommendations of utilizing five coders in the process of coding learning standards by only incorporating two coders. In addition, this study excluded Grades 6–8 by focusing on the Grades 9–12 CCSS and NJCCCS in language arts and mathematics. The major findings of this study using the DOK framework were as follows:

1. When using DOK as an analytic framework, the findings indicate that overall both the Grades 9–12 ELA and math NJCCCS (2008) were rated at a higher level of cognitive complexity as compared to the Grades 9–12 ELA and math CCSS (2010).
2. The Grades 9–12 ELA NJCCCS were rated at an overall higher percentage of DOK Levels 3 and 4 than were the Grades 9–12 ELA CCSS.
3. The Grades 9–12 math NJCCCS were rated at an overall higher percentage of DOK Levels 3 and 4 than were the Grades 9–12 math CCSS.
4. The Grades 9–12 ELA and Math CCSS had a higher percentage of lower rated standards, DOK Levels 1 and 2, as compared to the Grades 9–12 ELA and math NJCCCS (Sforza, 2014).

### **Assessment of Cognitive Domain Frameworks**

#### **Bloom’s Original Taxonomy (Bloom 1)**

In 1956, Benjamin S. Bloom and his colleagues developed a framework for classifying educational goals and objectives into a hierarchical structure representing different forms and levels of learning (Bloom et al., 1956). This framework was published as Bloom's taxonomy of educational objectives and consisted of the following three domains:

- the cognitive domain – knowledge-based domain, consisting of six levels, encompassing intellectual or thinking skills;
- the affective domain – attitudinal-based domain, consisting of five levels, encompassing attitudes and values; and
- the psychomotor domain – skills-based domain, consisting of six levels, encompassing physical skills or the performance of actions (International Assembly for Collegiate Business Education, 2016).

In higher education, the cognitive domain has been the principal focus for developing educational goals. Each of these three domains consists of a multi-tiered structure for classifying learning according to increasing levels of cognitive complexity. Teasing out the cognitive domain, Bloom's taxonomy is a six-level classification system that uses observed student behavior to infer the level of student achievement. Moving from simple to more complex, the taxonomy's levels include:

- knowledge – the remembering of previously learned material, which involves the recall of a wide range of material, from specific facts to complete theories;
- comprehension – the ability to grasp the meaning of previously-learned material, which may be demonstrated by translating material from one form to another, interpreting material (explaining or summarizing), or by predicting consequences or effects;

- application – the ability to use learned material in new and concrete situations, which may include the application of rules, methods, concepts, principles, laws, and theories;
- analysis – the ability to break down material into its component parts so that its organizational structure may be understood, which may include the identification of the parts, analysis of the relationships between parts, and recognition of the organizational principles involved;
- synthesis – the ability to put parts together to form a new whole, which may involve the production of a unique communication (thesis or speech), a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information); and
- evaluation – the ability to judge the value of material for a given purpose; the judgments are to be based on definite internal and/or external criteria. (IACBE, 2016)

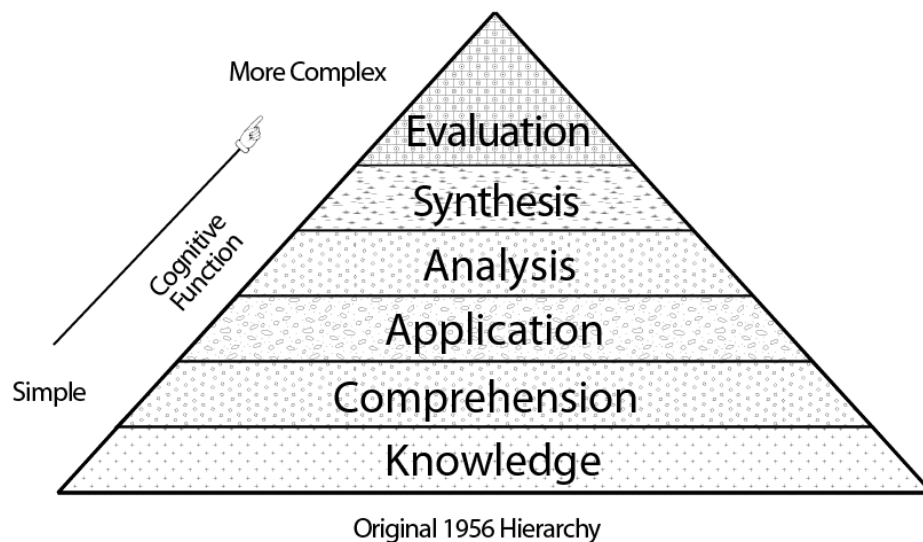
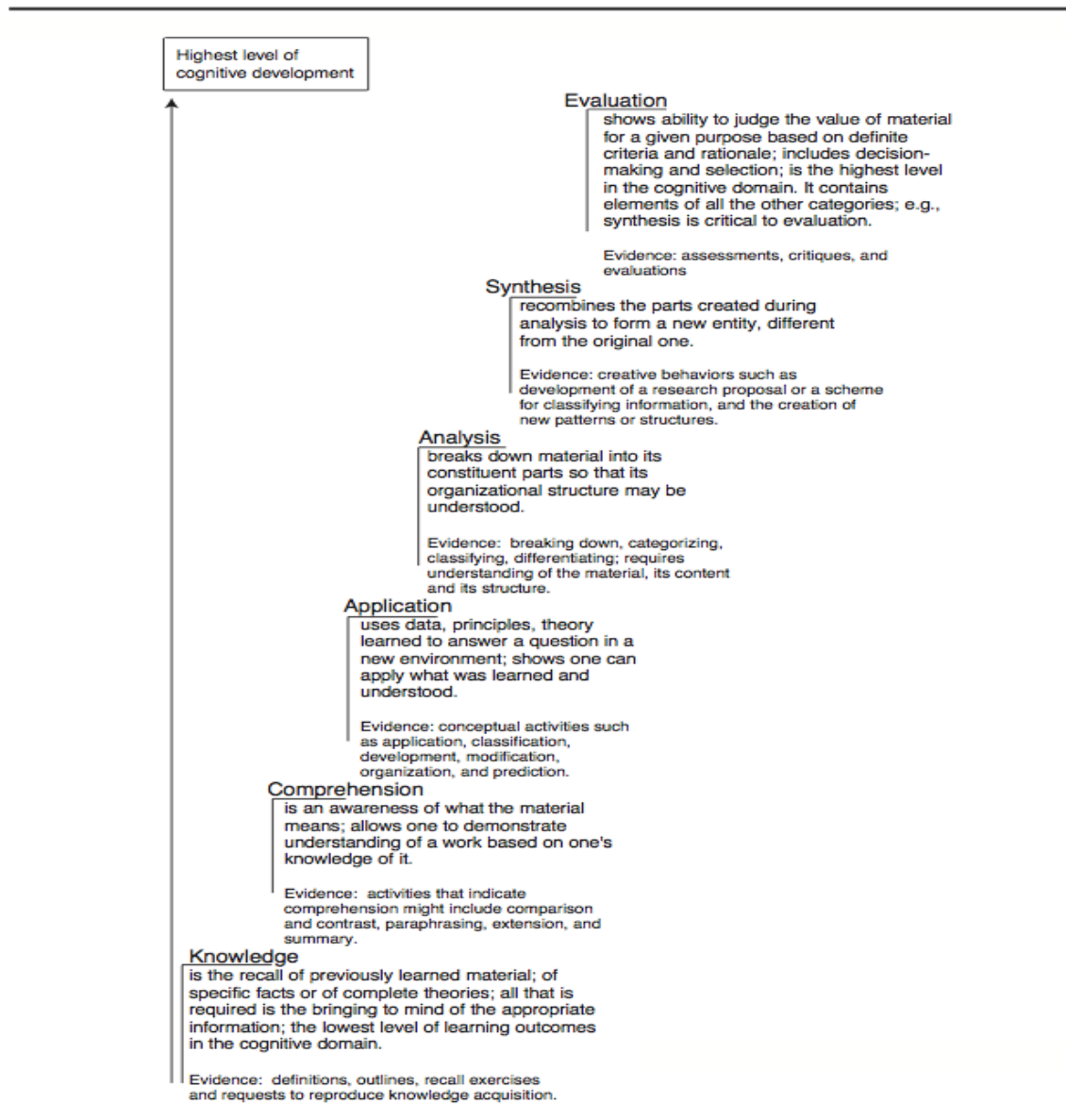


Figure 2. Bloom's hierarchy (Bloom's et al., 1956).

These various levels of cognitive development are illustrated in Athanassiou, McNett, and Harvey (2003) in Figure 3.



**Figure 1: Bloom's Taxonomy of Educational Objectives: Cognitive Domain**  
SOURCE: Adapted from Bloom (1956) and Grondlund (1970).

Figure 3. Bloom's taxonomy of educational objectives: Cognitive domain (Athanassiou, McNett, & Harvey, 2003).



In curriculum discussions, the taxonomy serves to create a common language to describe increasing levels of cognitive sophistication required of curriculum and the students who interact with it (Athanassiou et al., 2003). One of the most frequent uses of the original Bloom's taxonomy has been to classify curricular objectives and test items in order to show the depth of the objectives and items across the spectrum of categories (Krathwohl, 2002). Bloom's taxonomy has received considerable recognition internationally within the evaluation community (Lewy & Bathory, 1994). It has stood the test of time, has been used by generations of curriculum planners and college and university professors, and has become the standard for developing frameworks for learning, teaching, and assessment (IACBE, 2016). Despite this, Bloom's taxonomy is not without its critics. Ennis (1985) contends that the concepts in the taxonomy are too vague and were never intended to be a statement of educational objectives, as it was only intended to be a system for classifying educational objectives (p. 47). Objectives and standards can include the word *analyze*, but that analysis can be constricted to the purpose of finding one correct answer rather than leading to creative interpretation or development of an original response, as demonstrated by Hess's cognitive rigor matrix. Analysis can promote low-level thinking. For that reason, Bloom's original taxonomy would not be a sufficient framework for this study on assessing complex thinking required by specific learning standards. This framework is simply too broad to gauge the deeper levels of thinking sought after here.

### **Bloom's Revised Taxonomy (Bloom 2)**

Anderson and Krathwohl (2001), both of whom served on the early taxonomy team in the early 1950s, introduced a revision of Bloom's taxonomy entitled A Taxonomy for Teaching, Learning, and Assessment. The revision updates the taxonomy for the 21st century and includes significant changes in terminology and structure. In the revised framework, action words or

verbs are used to label the six cognitive levels (IACBE, 2016). The revised taxonomy retains the original number of categories, six, but three categories were renamed, while the order of two categories was interchanged (Krathwohl, 2002). The revised taxonomy (Bloom 2) identifies the following new levels of cognitive learning (arranged from lower order to higher order levels of learning):

- remembering – retrieving, recognizing, and recalling relevant knowledge from long-term memory;
- understanding – constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining;
- applying – using information in new ways, carrying out or using a procedure or process through executing or implementing;
- analyzing – breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing;
- evaluating – making judgments based on criteria and standards through checking and critiquing, defending concepts and ideas; and
- creating – putting elements together to form a coherent or functional whole, reorganizing elements into a new pattern or structure through generating, planning, or producing (IACBE, 2016).

Wilson (2001) illustrates the comparison of Bloom 1 and Bloom 2 in her graphic:

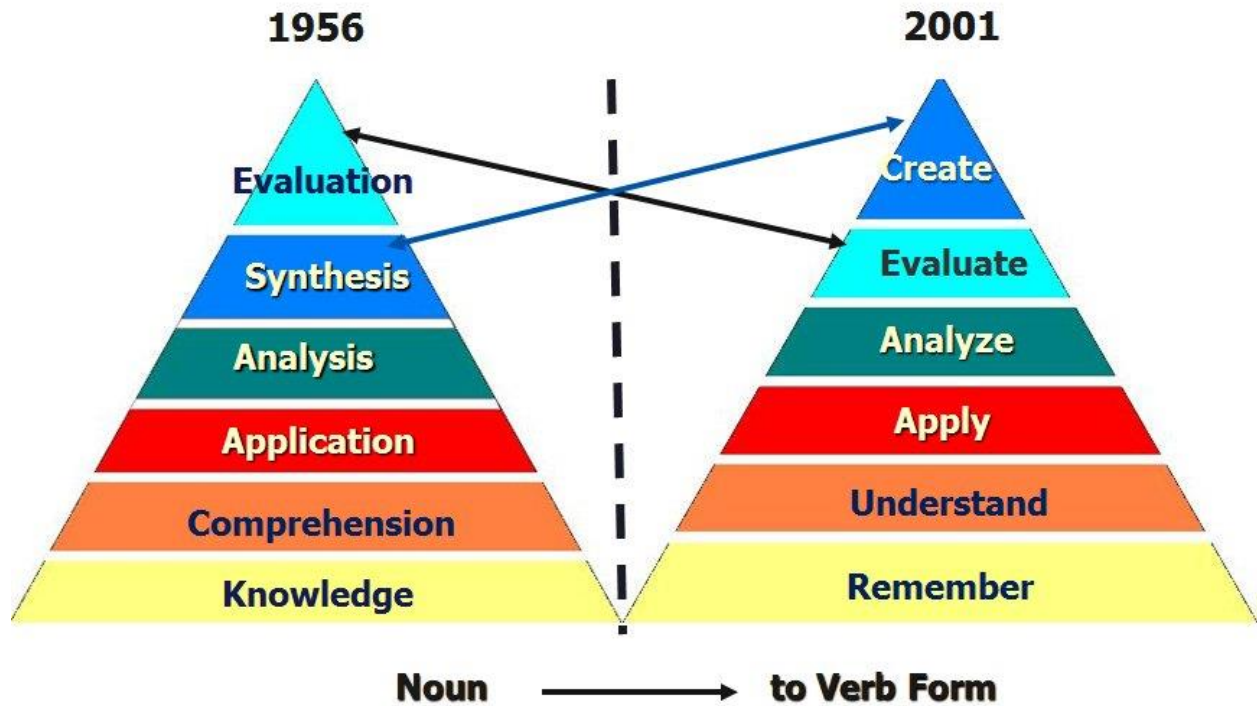


Figure 4. Revised Bloom's taxonomy (Wilson, 2001).

Like the original taxonomy, the revision is a hierarchy in the sense that the six major categories of the cognitive process dimension are believed to differ in their complexity, with remembering being less complex than understanding, which is less complex than applying, and so on (Krathwohl, 2002). According to Anderson and Krathwohl (2001), create is the highest category of the cognitive process. Create can be broken down into three processes: generating, planning, and producing. In generating, a student is given a description of a problem and must produce alternative solutions. In planning, a student develops a solution method when given a problem statement. In producing, a student is given a functional description of a goal and must create a product that satisfies the description (Mayer, 2002).

Bloom's revised taxonomy has proven to be more descriptive for assessing higher order thinking, especially with creativity, an element of complex thinking, taking over the top tier of

the taxonomy. The revised version is still broad as it addresses all types of learning, including both lower and higher levels of thinking. Although this taxonomy is certainly useful in other areas, it was not selected for my study as other frameworks better aligned with my goal for assessing the complex thinking required in learning standards.

### **Hess's Cognitive Rigor Matrix**

Hess, Carlock, Jones, & Walkup (2009) contributed a framework for determining cognitive demand called the cognitive rigor matrix. This unique approach stemmed from Hess's view of Bloom's revised taxonomy as not fully adequate for determining the level of cognitive demand of a particular educational objective (Hess, Carlock, Jones, & Walkup, 2009). Hess explained that different sources list somewhat different verb examples (e.g., write, summarize, test, explain, etc.) to represent intellectual activity on each of Bloom's levels and leads to confusion and uncertainty. Due to this variation, Hess felt that the verb indicators within Bloom's revised taxonomy were not sufficient to gauge the level of cognitive complexity within a test item (Hess, Carlock, Jones, & Walkup, 2009). In this cognitive rigor matrix, Hess made connections and distinctions between Bloom's revised taxonomy and Webb's depth-of-knowledge levels:

Although related through their natural ties to the complexity of thought, Bloom's Taxonomy and Webb's depth of knowledge differ in scope and application. Bloom's Taxonomy categorizes the cognitive skills required of the brain to perform a task, describing the type of thinking processes necessary to answer a question. depth of knowledge, on the other hand, relates more closely to the depth of content understanding and scope of a learning activity, which manifests in the skills required to complete the

task from inception to finale. Both the thinking processes and the depth of content knowledge have direct implications in curricular design, lesson delivery, and assessment development and use (Hess et al., 2009, p. 3)

Below is a sample of Hess's cognitive rigor matrix with specific English Language Arts Curriculum examples:

**Hess' Cognitive Rigor Matrix & Curricular Examples: Applying Webb's Depth-of-Knowledge Levels to Bloom's Cognitive Process Dimensions - ELA**

Revised Bloom's Taxonomy	Webb's DOK Level 1 Recall & Reproduction	Webb's DOK Level 2 Skills & Concepts	Webb's DOK Level 3 Strategic Thinking/ Reasoning	Webb's DOK Level 4 Extended Thinking
<b>Remember</b> Retrieve knowledge from long-term memory, recognize, recall, locate, identify	<ul style="list-style-type: none"> <li>Recall, recognize, or locate basic facts, details, events, or ideas explicit in texts</li> <li>Read words orally in connected text with fluency &amp; accuracy</li> </ul>			
<b>Understand</b> Construct meaning, clarify, paraphrase, represent, translate, illustrate, give examples, classify, categorize, summarize, generalize, infer a logical conclusion, predict, compare/contrast, match like ideas, explain, construct models	<ul style="list-style-type: none"> <li>Identify or describe literary elements (characters, setting, sequence, etc.)</li> <li>Select appropriate words when intended meaning/definition is clearly evident</li> <li>Describe/explain who, what, where, when, or how</li> <li>Define/describe facts, details, terms, principles</li> <li>Write simple sentences</li> </ul>	<ul style="list-style-type: none"> <li>Specify, explain, show relationships; explain why, cause-effect</li> <li>Give non-examples/examples</li> <li>Summarize results, concepts, ideas</li> <li>Make basic inferences or logical predictions from data or texts</li> <li>Identify main ideas or accurate generalizations of texts</li> <li>Locate information to support explicit-implicit central ideas</li> </ul>	<ul style="list-style-type: none"> <li>Explain, generalize, or connect ideas using supporting evidence (quote, example, text reference)</li> <li>Identify/ make inferences about explicit or implicit themes</li> <li>Describe how word choice, point of view, or bias may affect the readers' interpretation of a text</li> <li>Write multi-paragraph composition for specific purpose, focus, voice, tone, &amp; audience</li> </ul>	<ul style="list-style-type: none"> <li>Explain how concepts or ideas specifically relate to other content domains or concepts</li> <li>Develop generalizations of the results obtained or strategies used and apply them to new problem situations</li> </ul>
<b>Apply</b> Carry out or use a procedure in a given situation; carry out (apply to a familiar task), or use (apply) to an unfamiliar task	<ul style="list-style-type: none"> <li>Use language structure (pre/suffix) or word relationships (synonym/antonym) to determine meaning of words</li> <li>Apply rules or resources to edit spelling, grammar, punctuation, conventions, word use</li> <li>Apply basic formats for documenting sources</li> </ul>	<ul style="list-style-type: none"> <li>Use context to identify the meaning of words/phrases</li> <li>Obtain and interpret information using text features</li> <li>Develop a text that may be limited to one paragraph</li> <li>Apply simple organizational structures (paragraph, sentence types) in writing</li> </ul>	<ul style="list-style-type: none"> <li>Apply a concept in a new context</li> <li>Revise final draft for meaning or progression of ideas</li> <li>Apply internal consistency of text organization and structure to composing a full composition</li> <li>Apply word choice, point of view, style to impact readers' /viewers' interpretation of a text</li> </ul>	<ul style="list-style-type: none"> <li>Illustrate how multiple themes (historical, geographic, social) may be interrelated</li> <li>Select or devise an approach among many alternatives to research a novel problem</li> </ul>
<b>Analyze</b> Break into constituent parts, determine how parts relate, differentiate between relevant-irrelevant, distinguish, focus, select, organize, outline, find coherence, deconstruct (e.g., for bias or point of view)	<ul style="list-style-type: none"> <li>Identify whether specific information is contained in graphic representations (e.g., map, chart, table, graph, T-chart, diagram) or text features (e.g., headings, subheadings, captions)</li> <li>Decide which text structure is appropriate to audience and purpose</li> </ul>	<ul style="list-style-type: none"> <li>Categorize/compare literary elements, terms, facts/details, events</li> <li>Identify use of literary devices</li> <li>Analyze format, organization, &amp; internal text structure (signal words, transitions, semantic cues) of different texts</li> <li>Distinguish: relevant-irrelevant information; fact/opinion</li> <li>Identify characteristic text features; distinguish between texts, genres</li> </ul>	<ul style="list-style-type: none"> <li>Analyze information within data sets or texts</li> <li>Analyze interrelationships among concepts, issues, problems</li> <li>Analyze or interpret author's craft (literary devices, viewpoint, or potential bias) to create or critique a text</li> <li>Use reasoning, planning, and evidence to support inferences</li> </ul>	<ul style="list-style-type: none"> <li>Analyze multiple sources of evidence, or multiple works by the same author, or across genres, time periods, themes</li> <li>Analyze complex/abstract themes, perspectives, concepts</li> <li>Gather, analyze, and organize multiple information sources</li> <li>Analyze discourse styles</li> </ul>
<b>Evaluate</b> Make judgments based on criteria, check, detect inconsistencies or fallacies, judge, critique			<ul style="list-style-type: none"> <li>Cite evidence and develop a logical argument for conjectures</li> <li>Describe, compare, and contrast solution methods</li> <li>Verify reasonableness of results</li> <li>Justify or critique conclusions drawn</li> </ul>	<ul style="list-style-type: none"> <li>Evaluate relevancy, accuracy, &amp; completeness of information from multiple sources</li> <li>Apply understanding in a novel way, provide argument or justification for the application</li> </ul>
<b>Create</b> Reorganize elements into new patterns/structures, generate, hypothesize, design, plan, produce	Brainstorm ideas, concepts, problems, or perspectives related to a topic or concept	<ul style="list-style-type: none"> <li>Generate conjectures or hypotheses based on observations or prior knowledge and experience</li> </ul>	<ul style="list-style-type: none"> <li>Synthesize information within one source or text</li> <li>Develop a complex model for a given situation</li> <li>Develop an alternative solution</li> </ul>	<ul style="list-style-type: none"> <li>Synthesize information across multiple sources or texts</li> <li>Articulate a new voice, alternate theme, new knowledge or perspective</li> </ul>

Figure 5. Hess's cognitive rigor matrix (Hess, Carlock, Jones & Walkup, 2009)

According to Hess, the CR matrix allows educators to examine the depth of understanding required for different tasks that might seem at first glance to be at comparable levels of complexity (Hess et al., 2009). In practical application, Hess's cognitive rigor matrix was used for analyzing mathematics and English language arts enacted (or taught) curriculum in two studies. Curriculum specialists analyzed thousands of samples of student work including

homework samples, tests, quizzes, and worksheets and aligned them with the corresponding matrix. The results of these studies found that the majority of the English language arts assignments were classified at DOK Level 2 and Bloom's Level 2. The results for mathematics fell lower on the matrix, with the majority of the assignments being rated DOK Level 1 and Bloom's Level 3. The study revealed that both Bloom's taxonomy and Webb's depth of knowledge can serve a useful purpose by measuring cognitive complexity at various levels (Hess et al., 2009, p. 7).

### **Blank, Porter, and Smithson's Surveys of Enacted Curriculum**

Blank, Porter, and Smithson (2001) created the Surveys of Enacted Curriculum (SEC) as a practical research tool for collecting consistent data on teaching practices based on teacher reports of what was taught in classrooms. The enacted curriculum data give states, districts, and schools a method of analyzing current classroom practices in relation to content standards and systemic initiatives (p. 5). The *enacted curriculum* is defined as the actual subject content and instructional practices experienced by students in classrooms (Blank et al., 2001). This is in contrast to the *intended curriculum*, which is the statements of what students should learn such as those found in learning standards and lesson plans. The Surveys of Enacted Curriculum approach employs a two-dimensional framework defining content at the intersections of topics and cognitive demands (Porter, McMaken, & Yang, 2011, p. 104). Porter et al.'s (2011) cognitive demand classification includes memorization, explanation, generating and understanding, investigation, and making connection. The cognitive demand definitions of the SEC are as follows:

- **Memorize, Recall**

Recite, reproduce, identify, recall, and describe.

- **Perform Procedures, Explain**

Follow procedures/instructions, summarize, identify purpose, main ideas, gather information, solve equations/formulas, routine word problems, organize or display data, read or produce graphs and tables, execute geometric constructions.

- **Demonstrate, Understand, Generate**

Communicate new ideas, create/develop connections, recognize relationships, explain findings, develop/explain relationships, integrate with other topics and subjects.

- **Conjecture, Generalize, Prove, Analyze, Investigate**

Determine the truth of a mathematical pattern or proposition, categorize/schematize information, compare and contrast, write formal and informal proofs, analyze data, make inferences, draw conclusions, predict probable consequences, reason inductively or deductively.

- **Solve Non-Routine Problems, Make Connections, Evaluate**

Apply and adapt a variety of appropriate strategies to solve problems, apply mathematics, recognize, generate, synthesize content and ideas from several sources, determine relevance appropriateness, credibility, test conclusions, hypotheses, generalize, and critique.

The Council of Chief State School Officers used Blank, Porter, and Smithson's SEC (2001) to conduct a content analysis study of the Common Core Standards compared to varying state standards. The CCSSO convened 35 specialists in math and ELA from 18 states. Teams of four to five specialists reviewed the standards and coded each objective in the standard to the SEC framework (Porter et al., 2011, p. 105). Although this study is impressive in its success of

determining alignment of the CCSS to individual state standards, the results only included alignment percentages for individual states as well as an overall rating for all states under each component of the framework (i.e., memorize, perform procedures, demonstrate understanding, etc.). In addition, due to a limit of available data to the researchers, many states were not included in this study. For New Jersey, the CCSS mathematics standards for Grades 3 and 8 were the only grades and subjects aligned to the NJCCCS. The ELA standards for the NJCCCS were not included in this particular study.

The Surveys of Enacted Curriculum (SEC) has been successfully utilized to analyze the levels of difficulty found in learning standards. Another strength of the SEC is its extensive incorporation of several states' curriculum standards into the analysis. This study was within the scope of my study but was not selected due to the framework's following weaknesses. First, for the purpose of assessing complex thinking, Webb's DOK (Webb et al., 2005) has been utilized more frequently than the SEC. Next, the focus of my study was to describe and compare the cognitive complexity of specific sets of curriculum standards, not the difficulty of the curriculum standards. Finally, this tool was not selected as the SEC is utilized to evaluate the enacted curriculum rather than the intended curriculum such as the evaluation of learning standards.

### **Newmann, Lopez, and Byrk's The Quality of Intellectual Work in Chicago Schools**

Newmann, Lopez, and Byrk (1998) created a framework to assess the cognitive demand of classroom assignments and student work. The study was based on the notion that teachers' assignments and student work comprise the most direct evidence we can collect about students' opportunities to learn and the competencies they demonstrate (Newmann et al., 1998, p. 7). This study set out to discover the frequency of students engaging in authentic intellectual work. This work involves original application of knowledge and skills rather than just routine use of facts



and procedures (Newmann et al., 1998, p. 12). This authentic work can be utilized simultaneously with complex or higher order thinking. Newmann et al. (1998) argue that this complex thinking is necessary for scholastic achievement and most importantly, success in life. “Citizens are called upon to exercise complex intellectual capacities in order to make a good living, to participate effectively in civic life, and to successfully manage personal affairs” (Newmann et al., 1998, p. 15).

Newmann et al. (1998) succeeded in designing standards for student work that are applicable and appropriate for all grade levels and disciplines. “The standards provide a common intellectual mission that can bridge otherwise divisive preferences for teaching different preferences for teaching different disciplines, different content within disciplines, or different groups of students” (Newmann et al., 1998, p. 18). Newmann et al. set out criteria for assessing assignments in writing as follows:

1. Construction of knowledge: The assignment asks students to interpret, analyze, synthesize, or evaluate information in writing about a topic, rather than merely to reproduce information.
2. Disciplined inquiry: Elaborated written communication: The assignment asks students to draw conclusions or make generalizations or arguments and support them through extended writing.
3. Value beyond school: Connection to students’ lives: The assignment asks students to connect the topic to experiences, observations, feelings, or situations significant in their lives.

Newmann et al. (1998) evaluated samples from 12 schools in the Chicago area. All samples were mathematics or writing samples from Grades 3, 6, and 8. Of the samples collected

from third grade, 43% provided no challenge for students in both writing and mathematics with less than 15% of this work falling in the *extensive* category. Grades 6 and 8 yielded somewhat better results. Writing for Grade 6 was assessed at 31% for providing no challenge, while mathematics echoed this at 28%. Assignments rated in the *extensive* category fell in the 24% for writing and 9% for mathematics. Grade 8 fared better with only 22% of writing samples and being assessed at the *no challenge* level, but a large 56% of mathematics assignments provided no challenge. Twenty-six percent of eighth grade writing was rated as providing extensive challenge, but less than 5% of mathematics assignments at this level required high levels of challenge. As seen in many reviews, this study found that writing made higher demands for authentic work (Newmann et al., 1998, p. 24). As a strength, Newmann et al. (1998) succeeded in designing a framework for describing and evaluating authentic student work. Although very useful at the practical level for determining the value of assigned student work, this framework would not sufficiently describe deeper levels of complex thinking, as is the purpose of my study. As another weakness, the rubric utilized in this framework to describe the complex thinking of an assignment simply does not align well to curriculum standards, as curriculum standards require specificity and depth as more appropriately found in other frameworks.

### **Yuan and Le's Deeper Learning Initiative: RAND Corporation**

The Deeper Learning Initiative was conducted by Rand Education, a unit of the RAND Corporation, for the William and Flora Hewlett Foundation (Yuan & Le, 2012). The William and Flora Hewlett Foundation's Education Program initiated a strategic initiative in 2010 that focused on student mastery of core academic content and their development of deeper learning skills. Examples of these deeper learning skills include critical thinking, problem solving, collaboration, communication, and learn-how-to-learn skills (Yuan & Le, 2012, p. iii). The goal

of this study was to track the extent to which U.S. students are assessed in a way that emphasizes deeper learning skills. Yuan and Le's (2012) goal of assessing the deeper learning skills currently being sought in public schools is very much aligned with my study of assessing the cognitive demand required by both the CCSS and NJCCCS learning standards.

Yuan and Le's (2012) study involved describing the cognitive demand of state achievement tests from 17 states. The state of New Jersey was not included in the study. The analysis involved only testing items in mathematics and English language arts at the third, eighth, and 11th grade levels based on the availability of the appropriate test data. Yuan and Le (2012) revealed several possible frameworks for conducting this study including Norman Webb et al.'s (2005) depth of knowledge, Andrew Porter's (2002) five-level cognitive rigor framework, Karen Hess et al.'s (2009) matrix that combines Webb's DOK and Bloom's taxonomy of educational objectives, Newmann et al.'s (1998) set of standards to evaluate cognitive demand of classroom assignments and student work and others. Although these frameworks differed in their structure and purpose, they all focused on describing the cognitive rigor elicited by the task at hand (Yuan & Le, 2012, p. xii). Among the frameworks considered, the researchers ultimately decided that Webb et al.'s (2005) DOK best met the needs of this initiative. "Webb's DOK framework is the most widely used to assess the cognitive rigor of state achievement tests and best suited the needs of this project" (Yuan & Le, 2012, p. xii).

For each state test, Webb's DOK framework was applied to analyze the cognitive rigor of individual test items. Two researchers and two subject experts rated the cognitive rigor of more than 5,100 released test items. Applying Webb's subject-specific descriptions for each of the DOK levels to the test items being assessed, the cognitive rigor of state mathematics and English Language Arts tests was low with most items being coded at DOK Levels 1 or 2. Open-ended

items had a greater likelihood of reaching DOK Levels 3 or 4 than did multiple-choice items (Yuan & Le, 2012, p. xvi). Furthermore, it was concluded that only 3–10% of U.S. elementary and secondary students were assessed on selected deeper learning skills through state mathematics and English language arts tests. The strengths of this research are the empirical evidence it provides for the need of educators to emphasize deeper levels of complex thinking in curriculum writing. In addition, Yuan and Le also show through their selection of Webb’s framework, the validity that this particular framework possesses. A weakness of this research is that Yuan and Le’s research focus was on describing the cognitive rigor of test items as opposed to curriculum standards, which is the focus in my study.

With the low cognitive demands of state assessments revealed in Yuan and Le’s (2012) study, the goal of the Deeper Learning Initiative was to increase the percentage of students assessed on deeper learning skills to at least 15% by 2017. In addition, this study calls for additional studies to be conducted that will support this goal by assessing the core content as integrated with critical thinking and problem solving (Yuan & Le, 2012, p. xvi). My study falls in line with this particular charge by assessing the thinking required of students by the CCSS at the sixth through eighth grade levels. Similar to Yuan and Le’s findings, Webb’s DOK best suited the needs of my study, as it has been successfully utilized to assess deeper levels of complex thinking in both test items and learning standards.

### **Theoretical Framework**

Pogrow (2015) describes how good theories organize a wide variety of empirical data into a succinct proposition from which a variety of testable predictions can be derived. He further explains that the desired characteristics of any theory include the following:

- fit with a wide variety of existing empirical data,

- support a variety of important predictions with verification efforts,
- explain “why” things work,
- are precise/specific/detailed, and
- are simple propositions to explain the data (Pogrow, 2015, p. 19).

Pogrow (2015) also differentiates academic theories from a personal theory of action. Academic theories are the specific theories of a topic discussed in research articles, while personal theories of action are based on accumulated experiential data (p. 12). In other words, personal theories of action are those formed from an individual’s experience in the field of study. Both academic and personal theories are of value and possess advantages and limitations. The advantages of academic theories are that this type considers more factors than typical personal theories of action, usually possesses a rich history, and can be better applied to a wide variety of situations. Some of the limitations of academic theory include the number of academic theories in education that cyclically pass in and out of style, the lack of empirical evidence that educational practices and decisions based on academic theory produce better results than those that are not, and the overall vagueness of many academic theories that often cannot be tested (p.15). Relatedly, the key advantage of personal theories of action is that these theories are generally highly specific and detailed and enable the leader to deal with a wide variety of issues efficiently. The largest limitation of this type of theory is that people tend to exaggerate the role of their personal skill that influenced a particular task/situation and underestimate the role that luck played in their success. Another problem with personal theories of action is that it is hard to determine how generalizable anyone’s theories are and whether they will be equally effective if other leaders use them (pp. 16–17.)

My purpose for this qualitative content analysis study was to describe and compare the distribution of cognitive complexity within the mathematics New Jersey Student Learning Standards (NJSLS) and the New Jersey Core Curriculum Content Standards (NJCCCS) in Grades 6–8. Despite the validity and success of the various frameworks reviewed in this literature review, Webb’s depth of knowledge best matched the particular focus of my study by offering a scale or levels in which to describe and compare complex thinking found in the CCSS and NJSLS at the middle school level. Webb conducted several studies in coding standards and aligning standards to assessments. In general, a curriculum standard is composed of a specific number of goals, which, in turn, comprised of a specific number of objectives (Webb, 2007, p. 9). Webb described what he claimed to be the importance of standards aligned to objectives: “Better aligned goals and measures of attainment of these goals will increase the likelihood that multiple components of any district or state education system are working towards the same ends” (Webb, 1997, p. 2).

According to Webb (1997), alignment is the degree to which expectations and assessments are in agreement and serve in conjunction with one another to guide the system toward students learning what they are expected to know and do (p. 4). Webb et al. (2005) originally designed the Webb Alignment Tool (WAT) to determine the alignment of curriculum standards to an assessment. However, this framework has been utilized to code and analyze curriculum standards based on their complexity levels in several related studies (Florida State University, 2013; Niebling, 2012; Sato et al., 2011; Sforza, 2014). Webb et al. (2005) states in the multiple purpose of the WAT:

Participation in an alignment analysis leads to increasing awareness of the type of knowledge and depth of knowledge that can be displayed or demanded in various content

areas, standards, and assessment items. Furthermore, the results of an alignment will not only help to determine the quality of the alignment, but also provide direction for how the district and state educational personnel can refine standards and/or identify more appropriate assessment items (Webb et al., 2005, p. 3)

Webb's depth of knowledge has become one of the key tools educators can employ to analyze the cognitive demand (complexity) intended by the standards, curricular activities, and assessment tasks (Hess, 2013). Webb's depth of knowledge has been the most widely researched tool for assessing the alignment of intended, enacted, and assessed curriculum (Wyse & Viger, 2011). Webb (1997, 2007) uses four standards to address alignment issues:

1. *Categorical congruence* measures the extent to which the same or consistent categories of content appear in both the content standards and the assessment.
2. *Depth of knowledge (DOK) consistency* measures the extent to which the cognitive demands in the content standards are the same as to what people are required to know and do on the assessment.
3. *Range of knowledge correspondence* measures the extent to which the content standards and the assessment cover a similar span of knowledge.
4. *Balance of representation* measures the extent to which the knowledge is distributed similarly in the content standards and the assessment.

The theoretical framework for my study encompasses Webb's second criterion of depth-of-knowledge (DOK) consistency. According to Webb (1997), depth of knowledge possesses several dimensions such as the cognitive complexity of information students should be expected to know, how well they transfer this knowledge, make generalizations, and how much prerequisite knowledge they must possess in order to grasp ideas (p. 15). "The depth of

knowledge or cognitive demands of what students are expected to be able to do is related to the number and strength of the connections within and between mental networks” (Webb, 1997, p. 15). The DOK level of any learning objective should reflect the complexity of the objective rather than its difficulty. The DOK level describes the kind of thinking involved in a task, not the likelihood that the task will be completed correctly (Webb, 2005). Webb’s (2007) four depth of knowledge levels were used as the theoretical framework for this study:

*Level 1 (recall):* Items at this level require examinees to recall a simple definition, term, fact, procedure, or algorithm.

*Level 2 (skill/concept):* Items at this level require examinees to develop some mental connections and make decisions on how to set up or approach a problem or activity to produce a response.

*Level 3 (strategic thinking):* Items at this level require examinees to engage in planning, reasoning, constructing arguments, making conjectures, and/or providing evidence when producing a response. Items at this level require some complex reasoning and connections to be made.

*Level 4 (extended thinking):* Items at this level require examinees to engage in complex planning, reasoning, conjecturing, and development of lines of argumentation. Items at this level require examinees to make multiple connections between several different key and complex concepts.

As required by 21st century learning, the goal of learning standards is to require students to participate in complex, higher order thinking as they complete an assignment, project, or task. This type of thinking occurs at Webb’s Level 3 (strategic thinking) and Level 4 (extended thinking). Level 3 (strategic thinking) requires cognitive demands that are complex and abstract.



The complexity does not result from the fact that there are multiple answers but because the task requires more demanding reasoning. Level 3 activities include drawing conclusions from observations, citing evidence, and developing a logical argument for concepts, explaining phenomena in terms of concepts, and using concepts to solve problems (Webb, 1999, p. 22).

As explained by Webb (1999), Level 4 (extended thinking) requires complex reasoning, planning, developing, and thinking most likely over an extended period of time. The cognitive demands of the task should be high, and the work should be very complex. Students should be required to make several connections and have to select one approach from several alternatives on how the problem should be solved. Level 4 activities include designing and conducting experiments, making connections between concepts, combining and synthesizing ideas into new concepts, and critiquing experimental designs (p. 23). As the need arises to compare and contrast the complex thinking required in various sets of learning studies as completed in my study, it is reasonable to expect that as students proceed through the grades, more reasoning and analysis (Levels 3/4) will be expected of them and less simple recall and recognition (Webb, 2007, p. 22).

An explanation of the methodology for this study is presented in the next chapter. Chapter III includes an introduction to the present study, research questions, policy context, description of documents, and a description of the purpose and design of this study. Additional components of Chapter III include a review of the coding scheme utilized in the study, a description of the trained consultant coders' qualifications and experience, credibility statements, and how the standards were analyzed based on Webb's depth of knowledge (Webb et al., 2005).

## **Chapter III**

### **Methodology**

#### **Introduction**

This chapter includes the design, methodology, purpose, research questions, policy context, and description of documents used for analysis in this study. My purpose for this qualitative study was to describe and compare the distribution of cognitive complexity, as defined by Webb et al.'s (2005) depth of knowledge, between the New Jersey Student Learning Standards in mathematics and the New Jersey Core Curriculum Content Standards in mathematics for Grades 6–8. Public schools are charged by policymakers with developing students with what some have termed as 21st century skills, such as complex thinking in order to be successful contributors in an increasingly competitive job market (Kay, 2009; Kyllonen, 2012; Posner, 2002; Silva, 2009). “Without better curriculum, better teaching, and better tests, the emphasis on 21st century skills will be a superficial that will sacrifice long-term gains for the appearance of short-term progress” (Rotherham & Willingham, 2010, p. 20).

The NJSLS and NJCCCS curriculum standards in Grades 6–8 were selected due to the lack of descriptive and comparative research. Some argue that middle school is an important time to teach 21st century skills, as students at this age group are impressionable, curious, enthusiastic, and coming of age for deeper inquiry and abstract thinking (Kay, 2009).

#### **Research Questions**

1. To what extent is cognitive complexity, as defined by Webb's depth of knowledge (Webb et al. 2005), embedded in the New Jersey Student Learning Standards for Mathematics, Grades 6–8?

2. To what extent is cognitive complexity, as defined by Webb’s depth of knowledge (Webb et al. 2005), embedded in the New Jersey Core Curriculum Content Standards for Mathematics, Grades 6–8?
3. What differences and similarities exist in cognitive complexity between the New Jersey Student Learning Standards and New Jersey Core Curriculum Content Standards in mathematics for Grades 6–8?

### **Policy Context**

New Jersey has had state-mandated curriculum standards, known as the Core Curriculum Content Standards (NJCCCS), since 1996 in nine subject areas (NJDOE, 2017). The New Jersey State Board of Education voluntarily adopted the K–12 Common Core State Standards in 2010 to replace the previous English language arts and mathematics standards. The CCSS define what students from kindergarten through high school are expected to know and be able to do at the end of each grade level. These standards are not a curriculum. Local school districts have the responsibility to develop their own curricula that will assist teachers in ensuring that students adequately meet each learning standard.

Advocates for the Common Core State Standards claim that these new standards provide a framework for higher level skill development unlike previous standards and require students to produce evidence of learning through products that emphasize the use of higher level thinking skills (VanTassel-Baska, 2015, p. 60). The Common Core authors and supporters claim that the standards focus on skills, not about specific texts or methods used to teach those skills. Decisions about resources and methods are also claimed to be left to local school districts to decide (VanTassel-Baska, 2015).

Although very similar to the CCSS, The New Jersey State Board of Education in May 2016 gave final approval to the New Jersey Student Learning Standards (NJSLS) which, will outline the skills students should learn at each grade level. The math standards provide clarity and specificity rather than broad general statements. The new Mathematics standards will go into effect in New Jersey schools beginning in the 2017-2018 school year.

### **Research Design**

The design for this study is a qualitative case study. A case study is defined as an in-depth description and analysis of a bounded system (Merriam, 2009, p. 40). Similarly, Bogdan & Biklen, (2014) defined a case study as a detailed examination of one setting, or single setting, or a single subject, a single depository of documents, or a particular event (p. 271). Yin (2008) describes a case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (p. 18).

Case study research is a qualitative approach in which the investigator explores a bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information such as observations, interviews, documents, and reports (Creswell, 2007, p. 73). In all qualitative studies, researchers are concerned with the accuracy and comprehensiveness of their data (Bogdan & Biklen, 2014, p. 40). The general design of a case study starts wide and narrows as the researcher develops a focus and formulates questions regarding the system being studied. From broad exploratory beginnings, the researcher moves to more directed data collection and analysis (Bogdan & Biklen, 2014, p. 59).

Qualitative case studies offer both strengths and weaknesses. One strength of the case study is that it provides a structure for investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon being studied. Case studies are generally anchored in real-life situations and offer insights to others. The case design has proven particularly useful for studying educational innovations, evaluating programs, and informing policy (Merriam, 2009, p. 51). As a possible weakness, the qualitative case study design seeks to discover a rich description and analysis of a phenomenon; this requires an extensive amount of time and/or money. Also, qualitative case studies are limited by the sensitivity and integrity of the researcher because the researcher is the primary instrument of data collection and analysis (Merriam, 2009, p. 52).

The qualitative case study design is best suited for this study because the case study design seeks to advance a field's knowledge base. In addition, because of the aforementioned strengths of the case study, this is a particularly appealing design for fields of study like education (Merriam, 2009, p. 51). With so much emphasis on developing the complex thinking skills and dispositions in students, it is essential that educators, administrators, and policymakers evaluate current curricula to ensure that it is truly designed to cultivate those types of skills and dispositions.

## **Methods**

In this study, I utilized a qualitative content analysis method to code each set of standards and sub-standards. Analysis involves working with data, organizing them, breaking them into manageable units, coding them, synthesizing them, and searching for patterns (Bogdan & Biklen, 2014). Mayring (2000) defined qualitative content analysis as “an approach of empirical, methodological controlled analysis of texts within their context of communication, following

content analytical rules and step-by-step models” (p. 2). The content analysis process involves the simultaneous coding of raw data and the construction of categories that capture relevant characteristics of the document’s content (Merriam, 2009). Similarly, Berelson (1952) noted that the analyst in a content analysis aims to produce a quantitative classification of a given body of content, presented in categories devised to yield data relevant to specific hypotheses concerning that content (p. 15). Qualitative content analysis is an appropriate method for my research as it has already proven to be a reliable method for the coding of curriculum standards utilizing Webb’s DOK in several studies (Florida State University, 2013; Niebling, 2012; Sato et al., 2011; Sforza et al., 2016).

Deductive category application was utilized in this study to connect Webb et al.’s (2005) existing depth-of-knowledge framework to the existing NJSLs and NJCCCS (Mayring, 2000). Deductive category application is giving explicit definitions, examples, and coding rules for each category and determining exactly under what circumstances a text passage such as a learning standard can be coded with a particular category. Those category definitions are placed within a coding agenda.

Each depth-of-knowledge level of a standard represents a specific level of cognitive complexity; the higher the DOK level of a standard, the more cognitively complex the standard. Therefore, the higher the cognitively complex the standard, the more complex thinking is required in the standard. Figure 6 shows the step model of deductive category application utilized in this study adapted from Mayring (2000). This model was utilized to formalize the process of coding and analyzing the learning standards.

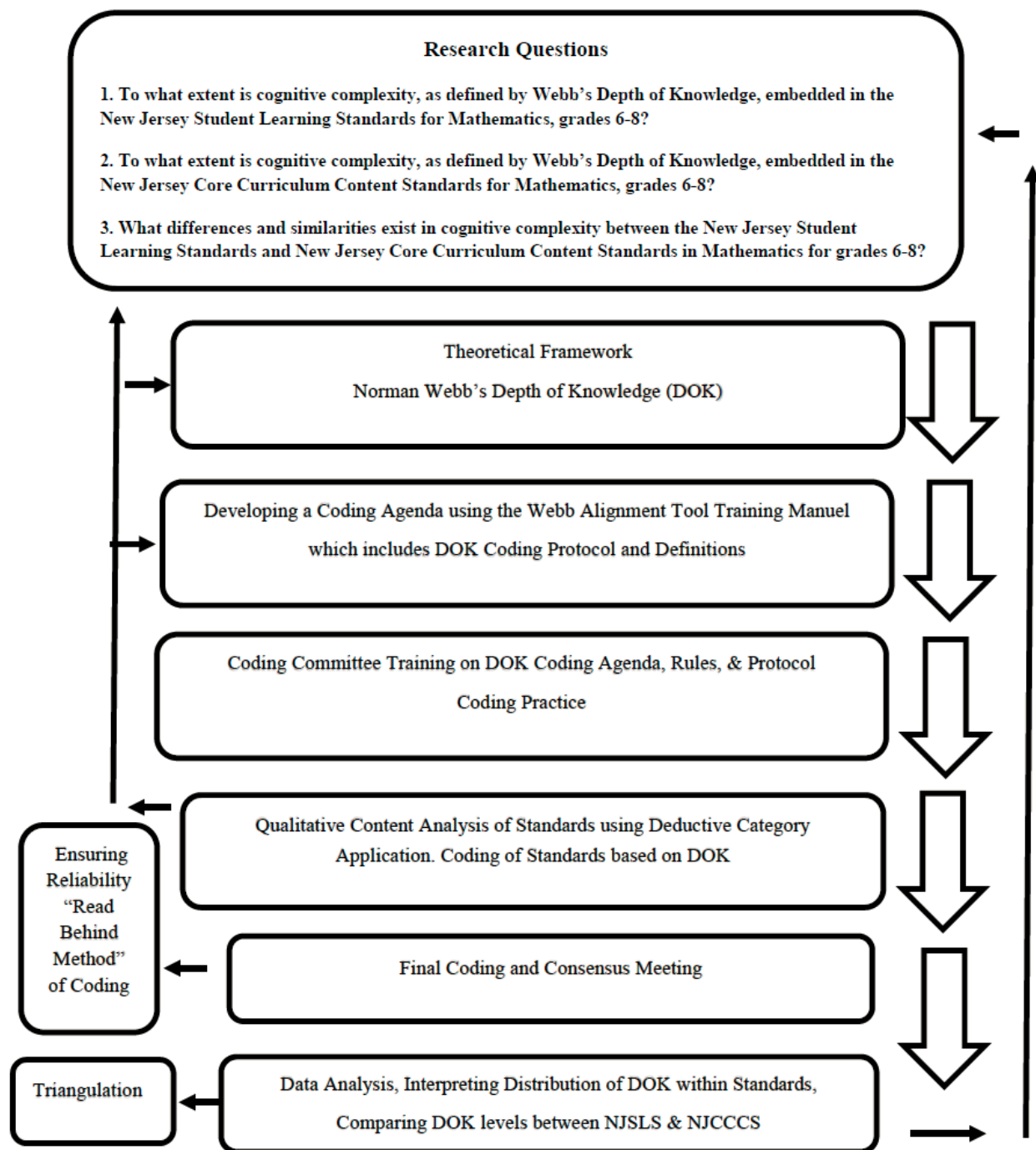


Figure 1 Step Model

Adapted from Mayring, (2000)

Figure 6. Coding step model adapted from Mayring (2000).

Determining the authenticity and accuracy of documents is part of the research process. The researcher must determine as much as possible about the document including its origin, purpose, and the context in which it was written. The reliability of the content analysis depends on the availability of the rich, appropriate, and well-saturated data available to the researcher (Elo et al., 2014). After assessing the authenticity and background of the documents, the researcher must adopt some system for coding the documents (Merriam, 2009, pp. 151–152). These documents are then to be analyzed step by step, following rules of procedure, devising the material into content analytical units (Mayring, 2000). In this study, the Grades 6–8 NJSLs mathematics standards and Grades 6–8 NJCCCS mathematics standards were analyzed and coded based on the corresponding DOK level. Each standard was rated 1–4 based on Webb et al.'s (2005) depth of knowledge methodology. Utilizing Mayring's (2000) template, a coding agenda was created based on recommendations given in the Webb Alignment Tool (Webb et al. 2005) training manual and followed throughout this study.

Similarly, the WAT was utilized to code standards in a study by Sato et al. (2011). As the WAT training manual recommends five analysts when coding and reaching consensus on each standard (Webb et al., 2005), this study deviated from Webb's protocol and utilized three analysts. Fewer analysts, using Webb's coding protocol, have already proven effective in several past studies that used the WAT to analyze and code standards based on their depth of knowledge complexity (Sato et al., 2011; Sforza, 2014; Yuan & Le, 2012). Inter-rater reliability was addressed in this study by including two qualified coders to this study's coding committee for a total of three coders.

Webb's depth-of-knowledge methodology, adapted from the Web Alignment Tool (WAT) training manual (Webb et al., 2005), is the most appropriate tool for the coding needs



undertaken in this study. Webb's (1997) alignment methodology was traditionally utilized to evaluate the alignment between academic content standards and academic content assessments but has been adapted to study the alignment between different sets of learning standards (Chi, Garcia, Surber, & Trautman, 2011, p. 6). The New Jersey Student Learning Standards (NJSLS) and the New Jersey Core Curriculum Content Standards (NJCCS) were analyzed using Webb's DOK levels derived from the WAT (Webb et al., 2005). Webb's second criterion taken from the WAT training guide is depth-of-knowledge (DOK) consistency. In this study, DOK was utilized to code and compare the cognitive complexity, complex thinking required in both the NJSLS and the NJCCCS at the sixth to eighth grade levels. Some studies have also utilized Webb's DOK to evaluate learning standards. Sato et al.'s (2011) study deviated from Webb et al.'s (2005) recommendations by giving multiple ratings to single CCSS learning standards. In addition, Florida State University's (2013) CPALMS study gave only one rating for each standard and sub-standard contained under that standard. My study sought to expand this research by not only analyzing unique grade levels but by specifying a DOK code for each standard and sub-standard within the mathematics NJSLS and NJCCCS in Grades 6–8. Webb et al.'s (2005) DOK levels were adapted for this study as follows:

Level 1 (recall): Items at this level require examinees to recall a simple definition, term, fact, procedure, or algorithm.

Level 2 (skill/concept): Items at this level require examinees to develop some mental connections and make decisions on how to set up or approach a problem or activity to produce a response.

Level 3 (strategic thinking): Items at this level require examinees to engage in planning, reasoning, constructing arguments, making conjectures, and/or providing

evidence when producing a response. Items at this level require some complex reasoning and connections to be made.

**Level 4 (extended thinking):** Items at this level require examinees to engage in complex planning, reasoning, conjecturing, and development of lines of argumentation. Items at this level require examinees to make multiple connections between several different key and complex concepts.

### **Description of Documents**

The term *document* is an umbrella term to refer to a wide range of written, visual, digital, and physical material relevant to the study at hand (Merriam, 2009, p. 139). The documents analyzed in this study were the NJSLS Mathematics Standards (NJDOE, 2017) and the NJCCCS mathematics standards (NJDOE, 2004). Both documents were downloaded from their websites on July 19, 2016, from the New Jersey Department of Education website. The NJSLS is a 99-page document that lists and gives background on learning standards from kindergarten through high school. My particular focus on assessing the sixth through eighth grade standards resulted in focusing on pages 39–58 of the document for this research. Pages 39–58 contain the sixth through eighth grade mathematics standards. For the sixth grade and seventh grade NJSLS mathematics standards, topics include ratios and proportional relationships, the number system, expressions and equations, geometry, and statistics and probability. For the eighth grade NJSLS mathematics standards, topics include the number system, expressions and equations, functions, geometry, and statistics and probability.

The 2004 NJCCCS mathematics standards is a 268-page document that is composed of nine sections organized by discipline. The mathematics standards are located in Section D and begin with a vision statement with a specific focus in mind. “These mathematics standards were

not designed as minimum standards, but rather as world-class standards which will enable all of our students to compete in the global marketplace of the 21st century” (NJDOE, 2004, p. D2). These standards are broken up in into five categories including number and numerical operations, geometry and measurement, patterns and algebra, data analysis, probability and discrete mathematics, and mathematical processes.

### **Coders**

The coding committee selected for this study possessed qualifications and perspectives that aided the validity of this research. The first consultant coder added to the team was a secondary school principal in New Jersey who holds a doctorate in educational leadership, management, and policy. In addition to his role as high school principal, he has also conducted research on the complexity of learning standards utilizing Webb’s DOK framework. The second consultant coder was a science, technology, engineering, and mathematics (STEM) supervisor for a large New Jersey middle school. Having consultants representing both the middle and high school levels increases the scope and perspective of this study.

### **Data Collection Methods**

A review of the literature suggested that Webb’s DOK methodology is closely linked to cognitive complexity, specifically the areas of creative and strategic thinking, both aspects of 21st century skills found in the extant literature. Webb’s DOK methodology provides definitions, rules, samples, and an efficient method of coding with only four detailed levels, as opposed to some methodologies that contain five or more levels. Webb et al.’s alignment tool training manual (2005) contains important definitions, explanations, and examples for coders to reference, including specific language distinguishing the four separate DOK levels in chapter III. Webb’s specific definitions of each DOK level assisted the coder’s reliability of the raters

utilized in my study. Listed below is a sample of rules adapted from the WAT training manual that the three coders followed when assigning DOK levels to each standard.

1. The DOK level of an objective should be the level of work students are most commonly required to perform at the grade level to successfully demonstrate their attainment of the objective.
2. The DOK level of an objective should reflect the *complexity* of the objective, rather than its *difficulty*. The DOK level describes the kind of thinking involved in a task, not the likelihood that the task will be completed correctly.
3. In assigning a DOK level to an objective, think about the complete domain of items that would be appropriate for measuring the objective. Identify the depth-of-knowledge level of the most common of these items.
4. If there is a question regarding which of the two levels an objective addresses, such as Level 1 or Level 2, or Level 2 or Level 3, it is usually appropriate to select the higher of the two levels.
5. The team of reviewers should reach consensus on the DOK level for each objective before coding any items for that grade level.

(Adapted from Webb et al., 2005, p. 36)

The WAT also included tips for facilitating the consensus process. These tips were also utilized as the three coders conducted their analysis of both sets of learning standards. The facilitator tips included the following:

- Read each objective aloud before discussing it.
- As you go through the objectives, actively solicit comments from all reviewers.

- Use your coding grid to call on people who coded DOK levels differently and ask them to explain their reasoning. Be sure to use the DOK definitions to justify answers.
- After two reviewers have described how they have coded an objective differently, ask a third reviewer to highlight the differences between these two interpretations.
- Ask if anyone, through other reviewers' explanations, would now like to change his or her mind about their original coding.
- If the viewpoints on the DOK level of an objective are divided, point to the most likely skills or content knowledge required in the objective, not the more extreme possibilities the objective might allow for.

(Adapted from Webb et al., 2005, p. 33)

Each deductive category within the step model has explicit definitions, examples, and DOK coding rules adapted from the WAT training manual. The descriptions ensured each coder understood precisely which DOK levels should be assigned to each standard. Mayring's (2000) step model was adapted for this study to include descriptions of Webb's depth-of-knowledge (DOK) levels that were extracted from the Webb Alignment Tool (WAT) training manual (Webb et al., 2005, pp. 45–46). A coding agenda was developed for assessing the mathematics standards of both the NJSLS and NJCCCS in Grades 6–8 as shown in figure 7. In addition, Webb's DOK wheel was utilized as an additional reference tool to ensure reliability and consistency within the coding process.

Category	Definition	Examples	Coding Rules
Level 1 (Recall)	Level 1 (Recall) includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. That is, in mathematics, a one-step, well defined, and straight algorithmic procedure should be included at this lowest level.	Read, write, and compare decimals in scientific notation.	Items at this level require a student to recall a simple definition, term, fact, procedure, or algorithm.
Level 2 (Skill/Concept)	Level 2 (Skill/Concept) includes the engagement of some mental processing beyond a habitual response. A Level 2 assessment item requires students to make some decision as to how to approach the problem or activity.	Construct two-dimensional pattern for three-dimensional models, such as cylinders and cones.	Items at this level require a student to develop some mental connections and make decisions on how to set up or approach a problem or activity to produce a response
Level 3 (Strategic Thinking)	Level 3 (Strategic Thinking) requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. In most instances, requiring students to explain their thinking is at Level 3. Activities that require students to make conjectures are also at this level. The cognitive demands at Level 3 are complex and abstract. The complexity does not result from the fact that there are multiple answers, a possibility for both Levels 1 and 2, but because the task requires more demanding reasoning.	Solve two-step linear equations and inequalities in one variable over the rational numbers, interpret the solution or solutions in the context from which they arose, and verify the reasonableness of results.	Items at this level require a student to engage in planning, reasoning, constructing arguments, making conjectures, and/or providing evidence when producing a response.
Level 4 (Extended Thinking)	Level 4 (Extended Thinking) requires complex reasoning, planning, developing, and thinking, most likely over an extended period of time. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and higher-order thinking. At Level 4, the cognitive demands of the task should be high and the work should be very complex. Students should be required to make several connections—relate ideas within the content area or among content areas—and have to select one approach among many alternatives on how the situation should be solved, in order to be at this highest level.	Design a statistical experiment to study a problem and communicate the outcomes.  For example, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as a Level 2.	Items at this level require a student to engage in complex planning, reasoning, and development of lines of argumentation. Items at this level require a student to make multiple connections between several different key and complex concepts.

Figure 7. Sample coding agenda for mathematics (Webb et al., 2005).

Adapted from the Webb Alignment Tool (WAT) training manual, Figure 8 shows a sample template of how Webb suggests analysts should code and record each standard. The template used in this study, adapted from the WAT training manual (2005), Niebling (2012), and Sforza's (2014) studies, was slightly modified to include only the learning standards applicable to this study (See Figure 9). Adapting Niebling and Sforza's templates added validity to this study as both studies were successfully utilized in coding learning standards using Webb's DOK. As stated in Chapter II, this study differed from previous studies on the cognitive complexity of the CCSS in that three coders were utilized, and only one DOK level was selected for coding each learning standard. Following Webb's recommendation, when coders had difficulty in reaching consensus on a particular learning standard, the higher of the two DOK levels was selected.

Wisconsin Grade 4 Mathematics Standards

Reviewer \_\_\_\_\_

Number	Standard	DOK Level
<b>1.</b>	<b>Number and Operations</b>	
1.a	Demonstrate number sense by comparing and ordering decimals to hundredths and whole numbers to 999,999	
1.b	Write money amounts in words and dollar-and-cent notation.	
1.c	Rename improper fractions as mixed and mixed numbers as improper fractions.	
1.d	Demonstrate addition and subtraction of fractions with common denominators.	
1.e	Round whole numbers to the nearest ten, hundred, or thousand and decimals to the nearest tenth.	

1.f	Solve problems, including word problems, that involve addition and subtraction of four-digit numbers with and without regrouping.	
1.g	Solve problems, including word problems, involving the basic operations of multiplication and division on whole numbers through two-digit multipliers and one-digit divisors.	
1.h	Recognize equivalent forms of commonly used fractions and decimals.	

Figure 8. Sample paper version of Webb's standards coding template (Webb et al., 2005, p. 97).

	<b>6<sup>th</sup> Grade Standards</b>	<b>DOK</b>	<b>Notes</b>
	<b>Ratios and Proportional Relationships 6.RP</b>		
<b>A.</b>	<b>Understand ratio concepts and use ratio reasoning to solve problems.</b>		
1.	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.		
2.	Understand the concept of a unit rate $a/b$ associated with a ratio $a:b$ with $b$ not equal to 0, and use rate language in the context of a ratio relationship.		
3.	Use ratio and rate reasoning to solve real-world and mathematical problems.		
3a.	Make tables of equivalent ratios relating quantities with whole number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.		
3b.	Solve unit rate problems including those involving unit pricing and constant speed.		
3c.	Find a percent of a quantity as a rate per 100; solve problems involving finding the whole, given a part and the percent.		
3d.	Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.		
	<b>The Number System 6.NS</b>		
<b>A.</b>	<b>Apply and extend previous understandings of multiplication and division to divide fractions by fractions.</b>		
1.	Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions.		



<b>B.</b>	<b>Compute fluently with multi-digit numbers and find common factors and multiples.</b>		
2.	Fluently divide multi-digit numbers using the standard algorithm.		
3.	Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.		
4.	Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1-100 with a common factor as a multiple of a sum of two whole numbers with no common factor.		

Figure 9. NJSLS Grade 6–8 mathematics DOK coding template sample. Source: Adapted from Webb et al., 2005, p. 97).

### Reliability and Validity

Merriam (2009) defines reliability as the extent to which research findings can be replicated. In other words, if the study were repeated, would the same results occur? Bogdan and Biklen (2014) define reliability as consistency between the data you collect and the empirical world you are studying. These definitions should not be confused with definitions for validity. Merriam (2009) separates validity into two types. Internal validity is described as the extent to which research findings are credible, whereas external validity involves the extent to which the findings of a qualitative study can be generalized or transferred to other situations (p. 234). To address the issue of reliability and validity in this qualitative content analysis, all theory and procedures underlying the study were explained for readers to reproduce. Triangulation was utilized, which involves the use of multiple coders in assigning DOK levels to curriculum standards and specific explanations of how the findings were derived from the data are all integrated here by the researcher for full disclosure and replication.

According to Merriam (2009), one of the greatest advantages of using documentary material is its stability. Documentary material exists separate from the research agenda; therefore, the document is unaffected or changed from the research process or by the researcher (Merriam, 2009, pp. 155–156). Along with the stability within authentic documents, such as the New Jersey Student Learning Standards and the New Jersey Core Curriculum Content Standards, additional methods were utilized in this study to increase the validity of the research. Merriam stated that whether someone is conducting a study or wants to make use of someone else's research in their practice, the validity and trustworthiness of the research is most vital (p. 166). Merriam suggested that triangulation, in a content analysis study, can help increase the credibility of qualitative research (p. 215). Merriam described four kinds of triangulation researchers can use to increase validity:

1. use of multiple methods (observations),
2. multiple sources of data (documents),
3. multiple investigators (interviews), and
4. multiple theories (p. 215).

In order to increase validity for this study, the coding methods from studies on similar topics were compared and incorporated into this research. In order to assess the reliability of the coding, at least two different researchers must code the same content (Mouter & Vonk Noordegraaf, 2012). This study utilized three analysts in coding each of the standards and compared our findings to increase our inter-rater reliability. The method used for this comparison was the read behind consensus model, which demonstrated to be an effective mode for the reliable coding of learning standards (Niebling, 2012; Sato et al., 2011; Sforza, 2014). The read behind consensus model calls for one rater to independently assign DOK codes to standards,

while the second rater reviews the codes of the first rater to determine if he/she agrees, noting agreement and disagreement. The raters then discuss any discrepancies in an ongoing manner, working to achieve consensus on these discrepancies (Niebling, 2012, p. 22). In the case of this study, the first and second coders worked collaboratively to code the standards, while the third coder conducted the read behind of both coders work. Mouter and Vonk Noordegraaf (2012) suggest five steps in ensuring that a coding assignment is reliable. These steps were implemented during this study:

1. Determine the scope of the intercoder reliability check by defining categories that are most relevant to the study.
2. Draft the protocol and rules to follow during analysis.
3. Practice/test the protocol on a smaller scale and adjust as needed.
4. Compare the findings of all coders.
5. Draw conclusions from the gathered data and analysis.

To further add validity and reliability to this study, all three analysts involved in this study were trained utilizing the Webb et al.'s WAT manual (2005) and engaged in several practice sessions to increase inter-rater reliability. The same data, coding agenda, and rules of coding were utilized for all three analysts during this study. All analysts are content and curriculum specialists and were adequately trained utilizing Webb's DOK to code learning standards. To ensure that the coding committee interpreted each standard for a DOK rating as is was intended by the authors of each set of learning standards, the committee worked to code all micro-standards first found within a category before returning to code the macro-standard. This validity and reliability strategy was utilized throughout the coding of both sets of learning standards.

## **Training and Calibration**

In order for a content analysis study to ensure reliability and validity, results of the research should be reported systematically and carefully, with particular attention paid to how connections between the data and results are reported (Elo et al., 2014). In order to provide such precision in this study, all three coders were trained using Webb et al.'s (2005) DOK protocol. The coding committee reviewed Webb's training manual and conducted several meetings to discuss and execute the coding agenda. In addition, we used practice-coding sessions to familiarize coders with the coding process and the read behind method. The practice sessions were organized and documented prior to the coding of any learning standards to ensure that all participants were proficient in the study's objectives and context. Similar to the study conducted by Niebling (2012), all coders received an overview of the study, familiarized themselves with the materials and process, and thoroughly researched the DOK level descriptions. Webb et al.'s (2005) Alignment Tool training manual was studied in depth, as it contains important definitions, explanations, and examples (Chapters II & III). These definitions, explanations, and examples were utilized to complete the coding agenda for this study in order to solidify what each DOK level should represent specifically for mathematics standards.

Following the initial training meetings, the coding committee began to code the Grades 6–8 Mathematics New Jersey Core Curriculum Content Standards (NJDOE, 2004), utilizing the read behind consensus model and aforementioned coding rules. The coding committee began by coding and comparing the first 10 learning standards for inter-rater agreement. After a high rate of agreement of 80% or better, the next 20 learning standards were coded and again compared for inter-rater agreement with the same goal of 80% or better. The remaining standards were coded in groups of 20, and this process of checking for inter-rater reliability was repeated

throughout the process. Throughout the project, all other coders reviewed my DOK findings and noted agreements or disagreements with each coded standard. Any disagreements among the three analysts were noted and discussed. These discussions continued until a consensus was reached. This process of utilizing the read behind consensus model continued with the coding of the Grades 6–8 Mathematics New Jersey Student Learning Standards (NJDOE, 2017). Following the completion of all the coding of the NJCCCS and NJSLS, the results of this analysis were compared to related studies that have coded learning standards utilizing Webb’s DOK (e.g., Niebling, 2012; Sato et al., 2011; Sforza, 2014).

### **Data Analysis Procedures**

The data used for this content analysis study consisted of coding two sets of mathematics standards from the 2009 New Jersey Core Curriculum Standards and the 2015 New Jersey Student Learning Standards. No empirical evidence currently exists regarding the DOK levels of the NJSLS in Grades 6–8 compared to the DOK levels contained in the NJCCCS at these same grade levels. As the NJCCCS has been replaced by the NJSLS due to the claims of the development of superior thinking skills for New Jersey’s students, it is essential that these claims be affirmed or denied to ensure that our students are truly given the necessary tools for success in an increasingly complex, globally competitive economy.

Similar to Sforza’s (2014) study and the Florida State University (2013) study, the percentage of learning standards at each depth-of-knowledge (DOK) level was calculated and graphed, including all sub-standards. The coding of all anchor standards and sub-standards of both the NJCCCS and NJSLS is an improvement over other related studies who only included the anchor standards or assigned multiple DOK ratings to learning standards in their research (Niebling, 2012; Sato et al., 2011). Anchor standards are the overall, big-picture learning

standards that a student must demonstrate, while sub-standards are the specific skills related to that anchor standard. The Sforza (2014) study compared the NJCCCS for mathematics and language arts in Grades 9–12, and the anchor standards and the sub-standards related to that anchor were also coded. Every anchor standard and corresponding sub-standard was coded as part of this study. The coders found the process of coding the anchor standards and corresponding sub-standards much more precise as professional educators generally form multiple lesson objectives that closely resemble sub-standards from larger anchor standards.

Results from both the NJSLs and NJCCCS mathematics standards in Grades 6–8 were separately calculated, summarized, and reported in the next chapter along with a comparable analysis of the two sets of learning standards. The graphics are utilized to depict important findings, patterns, and trends, which assist in addressing the research questions set out by this study. For Research Questions 1, 2, and 3, the following formula was used to calculate the percentage of standards at each DOK level:

$$\% \text{ of standards} = \frac{\# \text{ of standards coded at the DOK level}}{\text{total \# of possible standards}}$$

For example, if there are 132 mathematics standards in the NJSLs, 50 of which are coded at a DOK level of 1. Using the formula above, we would get the following result:

$$\frac{50}{132} = 38\% \text{ at DOK Level 1}$$

This basic formula was utilized to calculate all percentages of DOK distribution in both the NJSLs and NJCCCS mathematics curriculum standards at the Grade 6–8 level.

### **Role of the Researcher**

The perspective that I bring to this research is one of a practicing school administrator in the state of New Jersey. I taught students in both urban and suburban school districts, served on curriculum design committees, and served as an assistant principal at both the elementary and middle school grade levels. This experience includes my current role as elementary principal in a large, suburban school district in which students traditionally score high on CCSS aligned tests. I have had teaching and evaluative experiences with both the CCSS and the NJCCCS throughout the course of my career on a practical level.

My initial biases toward the topic included my view of the CCSS as more basic and lower level than the previous NJCCCS. However, throughout the process I reminded myself that the purpose of research is to discover knowledge, not to prove a point. I continued to return to that simple premise throughout the study to ensure that I removed my personal biases, as best I could, throughout the process. In addition, the research design incorporated the use of three coders with diverse backgrounds, experiences, and perspectives to control for bias by one person. The read behind consensus method also helps to reduce the chance that one person's bias can drive the results of the study. Coders involved in this study represented all school levels including elementary, middle school, and high school levels. During the coding process, all coders sought to control for biases by discussing each standard extensively before assigning the standard a DOK level by consensus.

For this study, my role was group leader of the coding committee. Adapted from the WAT training manual (Webb et al., 2005), the role of group leader included the following tasks:

1. Enter the state standards for each set of curriculum standards onto an Excel document.
2. Train your reviewers on your content area's depth-of-knowledge (DOK) Levels and how to utilize the Excel platform.

3. Facilitate the consensus process for each set of curriculum standards. This is when reviewers come to agreement on the DOK level of each objective.
4. Enter the consensus DOK values for each objective in the curriculum standards utilizing the Excel platform. (Adapted from Webb et al., 2005, p. 9)

Utilizing the read behind consensus model and aforementioned coding rules, all coders reviewed the standards and sub-standards of both the NJCCCS and NJSLS. During this analysis, each learning standard was coded utilizing the guidelines set out by the WAT (Webb et al., 2005). As the coders analyzed each learning standard, the committee noted agreements or disagreements with each coded standard utilizing a coding sheet as modeled in Figure 9. Any disagreements among the three analysts were noted and discussed for consensus on each standard. If after this discussion consensus was not reached for a particular learning standard, this was also noted on the coding sheet.

The next chapter presents the findings of this study with the focus on answering all three research questions posed in Chapters I and III. It contains a descriptive comparison between the NJCCCS and the NJSLS in mathematics at the sixth to eighth grade levels. Several graphics were utilized in addition to detailed explanations in order to reveal the findings of this study and make comparisons between the two sets of learning standards analyzed here.



## **Chapter IV**

### **Results**

#### **Introduction**

Chapter IV presents the findings of this study as they address the three research questions posed in earlier chapters. This chapter provides a descriptive comparison between the NJSLS and the NJCCCS in mathematics at the sixth to eighth grade level. Eight coding committee meetings were held starting in the month of November of 2016 and ending in February of 2017. Webb et al.'s (2005) Alignment Tool (WAT) can be used to code and analyze curriculum standards based on their complexity levels. It is understood that the higher the DOK level of the standard, the higher the cognitive complexity required for that specific task/skill.

The DOK levels are as follows:

Level 1 (recall): Items at this level require examinees to recall a simple definition, term, fact, procedure, or algorithm.

Level 2 (skill/concept): Items at this level require examinees to develop some mental connections and make decisions on how to set up or approach a problem or activity to produce a response.

Level 3 (strategic thinking): Items at this level require examinees to engage in planning, reasoning, constructing arguments, making conjectures, and/or providing evidence when producing a response. Items at this level require some complex reasoning and connections to be made.

Level 4 (extended thinking): Items at this level require examinees to engage in complex planning, reasoning, conjecturing, and development of lines of argumentation.

Items at this level require examinees to make multiple connections between several different key and complex concepts (Adapted from Webb et al., 2005, p. 36.)

This study utilized three analysts in coding each of the standards and consistently compared our findings to increase our inter-rater reliability. The method used for this comparison was the read behind consensus model, which had already been implemented in several studies conducted to code specific learning standards (Niebling, 2012; Sato et al., 2011; Sforza, 2014). The read behind consensus model calls for one rater to independently assign DOK codes to standards, while the second rater reviews the codes of the first rater to determine if he/she agrees, noting agreement and disagreement. The raters then discuss any discrepancies in an ongoing manner, working to achieve consensus on these discrepancies (Niebling, 2012, p. 22). In the case of this study, the first and second coders worked collaboratively to code the standards, while the third coder conducted the read behind of each coder's work. The member check and read behind consensus model helped to identify any misinterpretations or bias.

Throughout this study, the same data, coding agenda, and rules of coding were used by all three coding committee members in order to reduce the amount of discrepancy prior to reaching consensus. If consensus could not be reached on a standard, we selected the higher of the two DOK levels based on Webb et al.'s (2005) recommendations. For example, on the mathematic on the New Jersey Student Learning Standards (NJDOE, 2016) standard Geometry 6.G.A.1., which states, "Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems (p.44) consensus was reached on DOK Level 3 rather than DOK Level 2. Although two coders initially rated this particular mathematics standard at a DOK Level 2, the rater that coded this standard at

a DOK Level 3 thoroughly explained why the standard should be rated at a DOK Level 3. His rationale included an understanding that applying the skills needed to find the area of various shapes in solving real-world problems requires higher levels of thinking, such as strategic thinking, which is found at DOK Level 3. The coders that rated this standard at DOK Level 2 were convinced, and consensus was reached on rating standard Geometry 6.G.A.1. at a DOK Level 3.

### **Findings for Research Question 1**

Research Question 1: To what extent is cognitive complexity, as defined by Webb et al.'s depth of knowledge, embedded in the New Jersey Student Learning Standards for Mathematics, Grades 6–8?

The New Jersey Student Learning Standards (NJSLS) for Mathematics in Grades 6–8 were coded using the Webb's depth-of-knowledge framework. Webb et al. (2005) assigns four depth-of-knowledge ratings, which increase in complex thinking from Levels 1 to 4. The distribution of standards rated at a DOK Level 1 within the Grades 6–8 NJSLS mathematics was 18 (See figure 10). A mathematics standard rated at a DOK Level 1 requires basic recall of facts and definitions and performing basic one-step and algorithmic problems. *Identify, recall, recognize, use, and measure* are some of the keywords that can be identified within a mathematics standard rated at a DOK Level 1 (Webb et al., 2005). Two examples of Grades 6–8 Math NJSLS coded at a DOK Level 1 are as follows:

The Number System 6.NS.B.2: Fluently divide multi-digit numbers using a standard algorithm (p. 42).

Expressions and Equations 8.EE.C.7: Solve linear equations in one variable (p. 56).

The distribution of standards rated at a DOK Level 2 within the Grades 6–8 NJSLs mathematics was 54% (See figure 10). A DOK Level 2 standard requires a student to develop some mental connections and make decisions on how to set up or approach a problem. Keywords that distinguish a Level 2 item include *classify, organize, estimate, and make observations* (Webb et al., 2005). Two examples of Grades 6–8 NJSLs mathematics coded at a DOK Level 2 are as follows:

The Number System 6.NS.C.7a: Interpret statements of inequality as statements about the relative position of two numbers on a number line diagram (p. 43).

The Number System 7.NS.A.1a: Describe situations in which opposite quantities combine to make 0 (p. 49).

The distribution of standards rated at a DOK Level 3 within the sixth to eighth grade NJSLs mathematics was 24% (See figure 10). Mathematics standards that were rated at a DOK Level 3 require students to explain their thinking. Activities at this level are complex and abstract not because there are multiple answers but rather a DOK Level 3 requires more demanding reasoning, planning, and the providing of evidence. Creating a valid argument for complex problems and situations that could yield more than one right answer would be the type of language in a mathematics standard rated at a DOK Level 3.

Two examples of Grades 6–8 NJSLs mathematics coded at a DOK Level 3 are as follows:

Ratios and Proportional Relationships 6.RP.A.3: Use ratio and rate reasoning to solve real-world and mathematical problems (p. 42).

Geometry 8.G. A.5: Use informal arguments to establish facts about the angle sum and exterior angle triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles (p. 58).

The distribution of standards rated at a DOK Level 4 within the sixth to eighth grade NJSLS mathematics was 4% (See figure 10). A DOK Level 4 mathematics standard requires students to reach extended levels of complex thinking. A DOK Level 4 standard requires complex reasoning, planning, developing, and thinking most likely over an extended period of time. This level requires high cognitive demands and students should be required to make several connections.

Two examples of Grades 6–8 NJSLS mathematics coded at a DOK Level 4 are:

Expressions and Equations 7.EE. B.3: Solve multi-step real-life problems and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies (p. 50).

Statistics and Probability 7.SP.C.7: Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy (p. 52).

Some commentators in the education and business literature state it is important to develop skills and dispositions related to complex thinking in students in order for them to become globally competitive (Standard Chartered Global Focus, 2010; World Economic Forum, 2015). *The Competitiveness and Innovative Capacity Report* states, “Given the pace of change in

today's global economy, investments to promote innovation deserve more emphasis than at any other time in the past" (U.S. Department of Commerce, 2012, pp. 2–3).

Commentators on global competitiveness use the terms *cognitive complexity*, *creativity*, *innovation*, *analytical thinking*, and *problem-solving skills* as proxies for the overall basket of future-ready skills known as 21st century skills (Binkley et al., 2011). Creativity, innovative thinking, critical thinking, and problem solving are examples of complex thinking deemed essential for future economic success in the mainstream education and business literature. Mathematics standards that are low in complex thinking and depth of knowledge, a measure of 21st century skills, will make it difficult for students to develop essential 21st century skills that lead to students becoming complex thinkers and problem-solvers (Gardiner, 1972, p. 327). On the other hand, standards high in complex thinking and depth of knowledge will enhance students' extended levels of thinking by enabling these students to think creatively and solve problems, communicate effectively, collaborate, find and assess information quickly, and effectively use technology (Soulé & Warrick, 2015, p. 178).

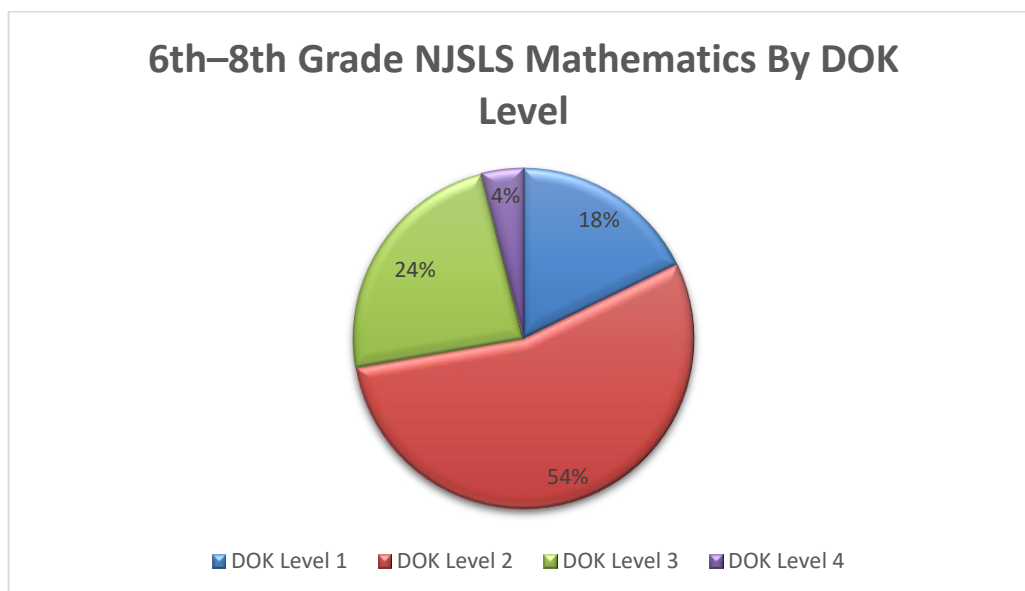


Figure 10. NJSL Mathematics DOK distribution.

## Findings for Research Question 2

Research Question 2: To what extent is cognitive complexity, as defined by Webb et al.'s depth of knowledge, embedded in the New Jersey Core Curriculum Content Standards for Mathematics, Grades 6–8?

The second set of learning standards coded in this study were the Grades 6-8 New Jersey Core Curriculum Content Standards (NJDOE, 2004) for Mathematics. New Jersey replaced these standards with the Common Core State Standards in 2010.

The distribution of DOK Level 1 in the Grades 6–8 mathematics NJCCCS was 20% (See figure 11). A mathematics standard rated at a DOK Level 1 requires basic recall of facts and definitions and performing single-step and algorithmic problems. Keywords that identify DOK Level 1 standards include, *identify, recall, recognize, use, and measure* (Webb et al., 2005). Two examples of Grades 6–8 mathematics NJCCCS coded at a DOK Level 1 are as follows:

Number Sense: 4.1.6. A.2. Recognize the decimal nature of the United States currency and compute with money (p. D-14).

Numerical Operations: 4.1.8.B.4. Solve problems involving proportions and percents (p. D-16).

The distribution of standards rated at a DOK Level 2 within the Grades 6–8 mathematics NJCCCS was 40% (See figure 11). A mathematics standard rated at a DOK Level 2 requires students to use mental processing beyond simple recall or demonstrating rote response. A DOK Level 2 contains keywords such as *classify, estimate, and make observations*. Some mental connections and decisions on how to set up or approach a problem or activity are required at this

level. Two examples of Grades 6–8 mathematics NJCCCS coded at a DOK Level 2 are as follows:

Estimation: 4.1.7.C.1. Use equivalent representations of numbers such as fractions, decimals, and percent to facilitate estimation (p. D-15).

Numerical Operations: 4.1.8.B.3. Find square and cube roots of numbers and understand the inverse nature of powers and roots (D-16).

The distribution of standards rated at a DOK Level 3 within the Grades 6–8 mathematics NJCCCS was 27% (See figure 11). A DOK Level 3 mathematics standard required the students to use strategic thinking with emphasis on reasoning, constructing arguments, and providing evidence when producing a response. Drawing conclusions from observations and deciding which concepts to apply in order to solve a complex problem are additional criteria for a DOK Level 3 standard. Two examples of Grades 6–8 mathematics NJCCCS coded at a DOK Level 3 are as follows:

Number Sense: 4.1.6.A.7. Develop and apply number theory concepts such as primes, factors, multiples, common multiples, and common multiples in problem solving situations (p. D-14).

Geometric Properties 4.2.7.A.1. Understand and apply properties of polygons.

Quadrilaterals, including squares, rectangles, parallelograms, trapezoids, rhombi; Regular polygons (D-22).

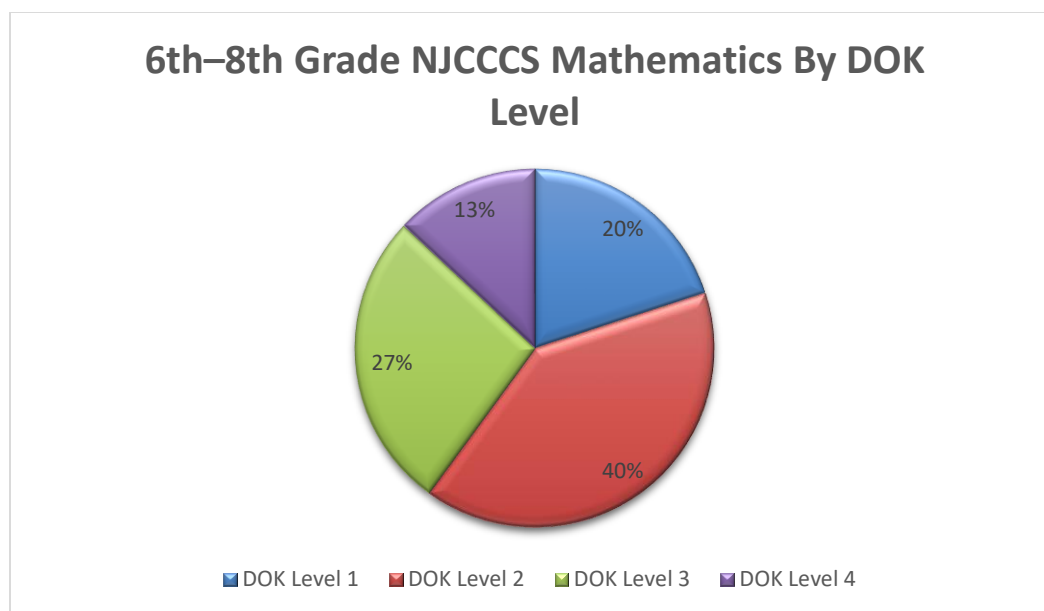
The distribution of standards rated at a DOK Level 4 within the Grades 6–8 mathematics NJCCCS was 13% (See figure 11). A DOK Level 4 mathematics standard requires students to reach extended forms of complex thinking, most likely over an extended period of time. The cognitive demands at this level are high, and students are required to make several connections



by relating ideas within the content area or among content areas. DOK Level 4 activities include complex thinking such as making multiple connections, critiquing, synthesizing, and designing experiments. Two examples of Grades 6–8 mathematics NJCCCS coded at a DOK Level 4 are as follows:

Geometric Properties 4.2.7. A.3. Use logic and reasoning to make and support conjectures about geometric objects (p. D-22).

Modeling 4.3.6.C.2. Draw freehand sketches of graphs that model real phenomena and use such graphs to predict and interpret events. Changes over time; Relations between quantities; Rates of change (e.g., when is plant growing slowly/rapidly, when is temperature dropping most rapidly/slowly) (p. D-29).



*Figure 11.* NJCCCS Mathematics DOK distribution.

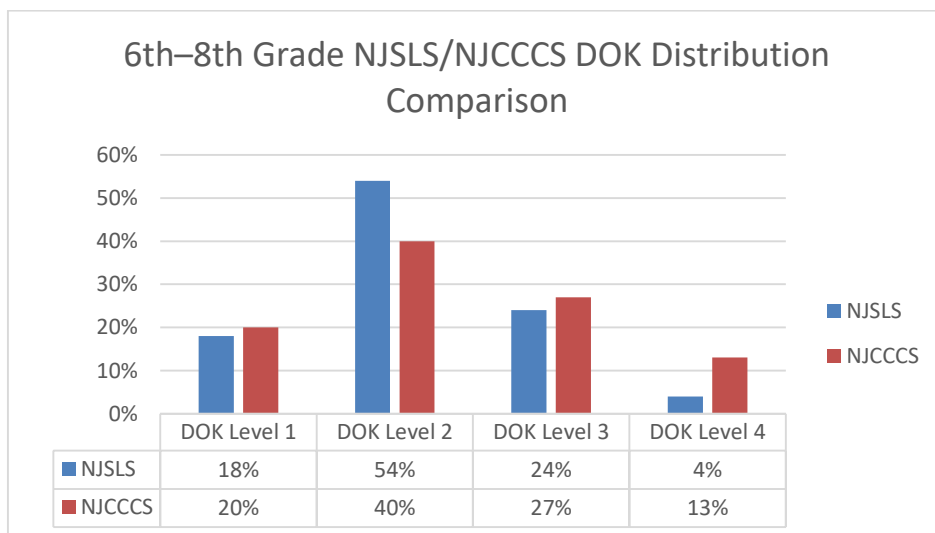
### **Findings for Research Question 3**

Research Question 3: What differences and similarities exist in cognitive complexity between the New Jersey Student Learning Standards and New Jersey Core Curriculum Content Standards in Mathematics for Grades 6–8?

The third research question for this study sought to understand, compare, and contrast the distribution of cognitive complexity between the two sets of standards, the NJSLS (NJDOE, 2016) and the NJCCCS (NJDOE, 2004). The data results are presented using a data array of graphs and charts.

### DOK Distribution

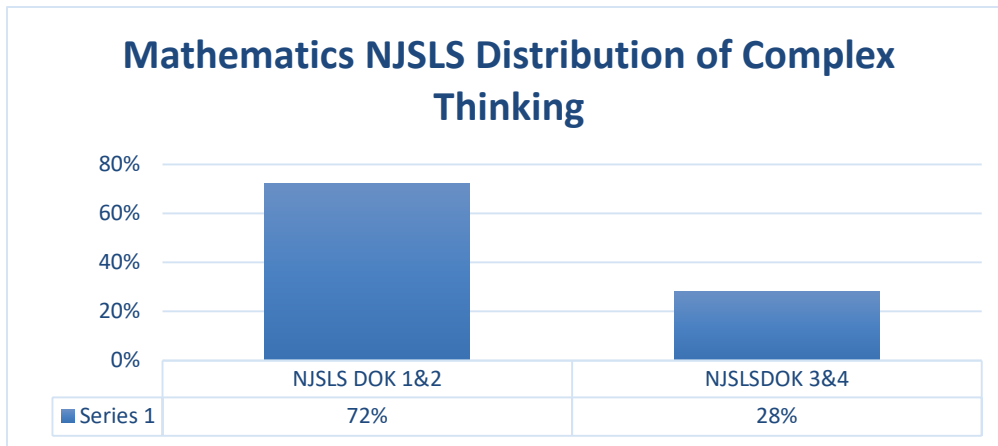
Figure 12 presents the cognitive complexity distribution between the Grades 6–8 NJSLS and Grades 6–8 NJCCCS in mathematics. As indicated, the math Grades 6–8 NJCCCS contained a higher percentage (20%) of standards rated at a DOK Level 1, as compared to the math Grades 6–8 NJSLS (18%). The data indicate that the distribution of DOK Level 1 thinking within the math Grades 6–8 NJSLS was 2% less than the distribution of DOK Level 1 within the Grades 6–8 NJCCCS. Of the math Grades 6–8 NJSLS, 54% were rated a DOK Level 2, compared to the math Grades 6–8 NJCCCS of 40%. This represents a DOK Level 2 percentage difference of 14%. The math Grades 6–8 NJCCCS had a DOK Level 3 percentage of 27%, which was 3% more than the math Grades 6–8 NJSLS percentage of 24%. The math Grades 6–8 NJCCCS also had a higher DOK Level 4 percentage of 13%, as compared to 4% contained in the math Grade 6–8 NJSLS. This represents a 9% difference between the NJCCCS and NJSLS at DOK Level 4.



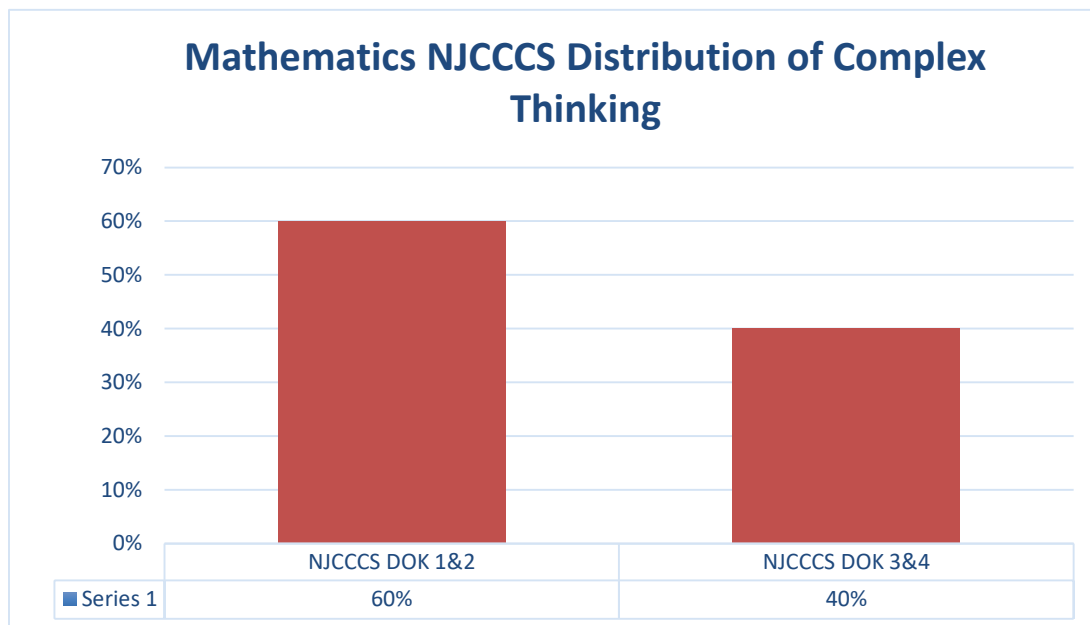
*Figure 12.* Comparison of cognitive complexity between the Grades 6–8 mathematics NJSLS and Grades 6–8 mathematics NJCCCS.

In order to reach higher levels of complex thinking, the highest levels of cognitive complexity contained at DOK Levels 3 and 4 must be reached. Figures 13 and 14 display the distribution of complex thinking contained in each set of learning standards. When DOK levels are grouped together, the reader can get a better understanding of the distribution of lower levels (DOK Levels 1 and 2) compared to higher levels (DOK Levels 3 and 4) within the learning standards. Figure 13 shows that of the math Grades 6–8 NJSLS; 72% of the learning standards were rated low in complex thinking, DOK Levels 1 and 2. DOK Levels 1 and 2 standards involve basic recall and use of simple problem-solving skills. Twenty-eight percent of the math Grades 6–8 NJSLS were rated high in complex thinking, DOK Levels 3 and 4, which involve strategic and extended forms of thinking.

Figure 14 displays the distribution of complex thinking within the math Grades 6–8 NJCCCS. Within the math Grades 6–8 NJCCCS, 60% of the learning standards were rated low in complex thinking at DOK Levels 1 or 2, which involve only basic recall and the use of simple problem-solving skills. Of the math Grades 6–8 NJCCCS, 40% of the learning standards were rated at higher levels of complex thinking, DOK Levels 3 and 4, which involve strategic and extended forms of thinking.



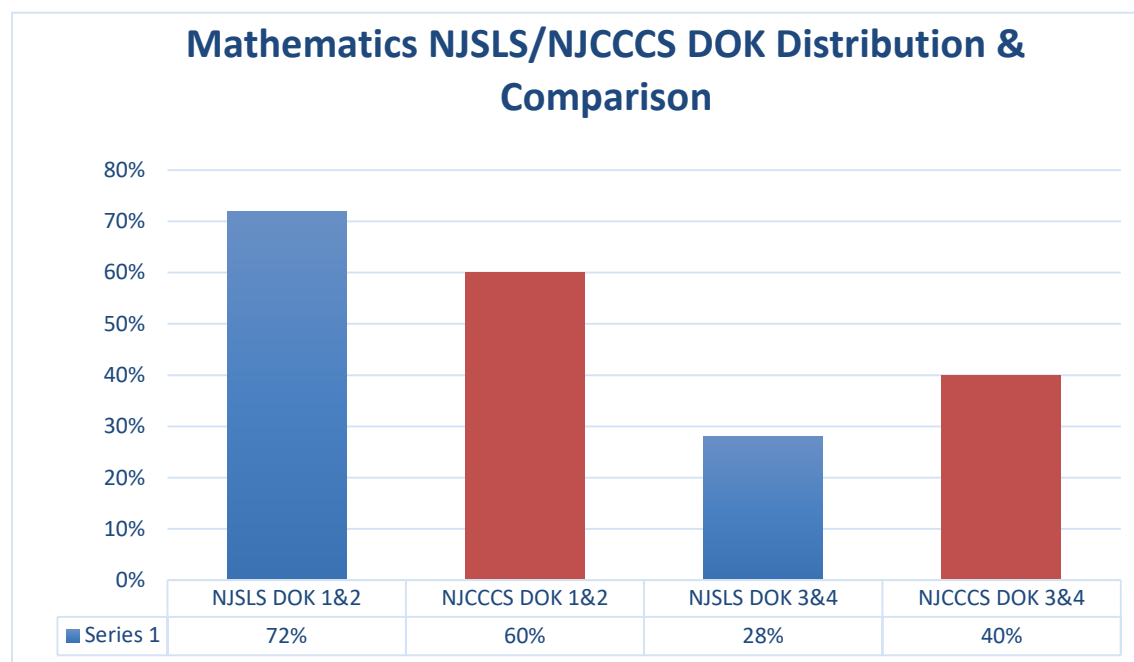
*Figure 13.* Distribution of complex thinking within Grades 6–8 mathematics NJSLS.



*Figure 14.* Distribution of complex thinking within Grades 6–8 mathematics NJCCCS.

Figure 15 displays the DOK distribution contained in both sets of mathematics learning standards (Grades 6–8 NJSLS and NJCCCS) graphed side by side. The math Grades 6–8 NJSLS are lower in complex thinking with 72% of the learning standards rated as a DOK Level 1 or 2 compared to the learning standards found in the NJCCCS in which 60% were rated as a DOK Level 1 or 2. Relatedly, the math Grades 6–8 NJCCCS provide students with more potential for

higher levels of complex thinking with 40% of the standards being rated as a DOK Level 3 or 4 as compared to the math Grades 6–8 NJSLS percentage of 28%.



*Figure 15.* DOK distribution comparison within Grades 6–8 mathematics NJSLS/NJCCCS.

### Conclusion

The purpose of this content analysis study was to describe and compare the distribution of cognitive complexity within the mathematics New Jersey Student Learning Standards (NJDOE, 2017) and the New Jersey Core Curriculum Content Standards (NJDOE, 2004) in Grades 6–8 using the Webb et al.’s depth-of-knowledge framework. As the potential for complex thinking increases as you increase DOK levels, learning standards that contain higher levels of complex thinking are superior to learning standards with lower levels of complex thinking in developing essential 21st century skills in students. The data in this chapter provided a descriptive comparison of the cognitive complexity distribution between the two sets of learning standards. As mandated by the three research questions, data analysis revealed specific

distribution percentages of cognitive complexity, coded as depth-of-knowledge (DOK) levels, within these standards. The major findings identified by comparing the math Grades 6–8 NJSLS and math Grades 6–8 NJCCCS utilizing the DOK framework include:

1. The mathematics Grades 6–8 NJCCCS were rated at an overall higher percentage of DOK Levels 3 and 4 than were the mathematics Grades 6–8 NJSLS.
2. The mathematics Grades 6–8 NJSLS contained a higher percentage of lower rated standards, DOK Levels 1 and 2, as compared to the mathematics Grades 6–8 NJCCCS.

Chapter V includes a summary of the study, statements regarding the study findings as they relate to the research questions, implications for policy and practice, and future research recommendations.

## **Chapter V**

### **Conclusions and Recommendations**

#### **Summary, Overview, Discussion, and Restatement of the Problem**

In this chapter, I provide a summary of the study, restate the problem originally posed, provide brief comments on the findings as they relate to this study's research questions, as well as draw conclusions, and make recommendations for policy and practice. Ideas for future research are presented at the end of the chapter. My purpose for this qualitative content analysis study was to describe and compare the distribution of cognitive complexity within the mathematics New Jersey Student Learning Standards (NJSLS) and the New Jersey Core Curriculum Content Standards (NJCCCS) in Grades 6–8. The middle school NJSLS have been selected for this study due to the lack of research and analysis of cognitive complexity contained in curriculum standards at the sixth to eighth grade level.

Webb et al.'s (2005) depth of knowledge (DOK) was utilized as the conceptual framework for this study. Webb's DOK consists of four levels of knowledge including Level 1, recall and Level 2, skills and concepts. Levels 1 and 2 require basic knowledge recitation, recall, and literal comprehension. Complex thinking, in the form of creative or strategic thinking, is not present in DOK Levels 1 and 2. Webb's depth-of-knowledge Levels 3 and 4 require strategic thinking and complex reasoning. The levels require students to think deeper and think analytically and strategically. Curriculum standards at DOK Levels 3 and 4 are where researchers argue students use complex thinking.

There are no studies at Grades 6–8 levels that have addressed the specific focus of comparing the cognitive complexity of the NJSLS and the previous set of NJCCCS. Determining the complex thinking embedded in the NJSLS will allow teachers, school administrators, and

policymakers to ensure that students are being trained in the type of thinking necessary for higher education and beyond. If complex thinking is not built into the NJSLS, then stakeholders must take the necessary steps to evaluate and revise the current learning standards to include complex thinking.

### **Summary of Methodology**

Webb et al.'s (2005) Alignment Tool (WAT) can be used to code and analyze curriculum standards based on their complexity levels and has been utilized as the framework for several related studies (Florida State University, 2013; Niebling, 2012; Sato et al., 2011; Sforza, 2014). Webb defines four levels of cognitive complexity as depth-of-knowledge levels, which include recall and reproduction, skill and concepts, strategic thinking, and extended thinking. It is understood that the higher the DOK level of the standard, the higher the complexity and creativity required for that specific task/skill. In this study, Webb et al.'s DOK was used to systematically analyze the cognitive demands of both the NJSLS and the replaced NJCCCS and gauge the complex thinking that each mathematics standard requires. The objective of this study was to assess the depth of the clues embedded in the language of the standard in order to determine if each standard helps a student develop complex thinking. A curriculum that is low in complexity and depth of knowledge will not adequately prepare students to develop essential 21st century skills that lead to creative and original thought (Gardiner, 1972). Relatedly, a curriculum high in complexity and depth of knowledge will enhance a student's creative abilities and deeper levels of thinking.

This study used a qualitative case study design with content analysis methods to describe and compare the percentages of the New Jersey Student Learning Standards and of the former New Jersey Core Curriculum Content Standards in Grades 6–8 mathematics that require students



to demonstrate complex thinking. Hsieh and Shannon (2005) defined qualitative content analysis as research methods for interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns.

Utilizing Mayring's (2000) step model to guide analysis, this study sought to code and compare the various DOK levels of each Grade 6–8 mathematics standard and subsequent sub-standards of both the NJSLS and NJCCCS in order to draw important comparisons and conclusions. The present study involved three analysts who were trained using Webb et al's (2005) depth-of-knowledge methodology, assigning a DOK level code to each of the standards and then comparing their data and findings, thus increasing inter-rater reliability (Merriam, 2009, p. 216). The “double-rater read behind consensus model” was utilized as part of this study and provided a reliable, systematic approach to coding each set of mathematics standards (Niebling, 2012, p. 22).

### **Discussion of Findings**

Dewey (1933) states that the sheer imitation of steps to be taken and mechanical drill may give results quickly but are fatal to reflective power (p. 51). An intended curriculum based on content standards that are low in cognitive complexity and depth of knowledge (DOK Levels 1 and 2) will make it difficult for students to experience an enacted curriculum designed to develop essential 21st century skills that lead to creative and original thought (Gardiner, 1972, p. 327). However, an intended curriculum based on content standards that are high in complexity and depth of knowledge will allow students to reach creative and extended levels of thinking by preparing them to “make multiple connections between several different key and complex concepts” (Gardiner, 1972, p. 327). If deeper levels of cognitive demand (DOK Levels 3 and 4) are less prevalent in a particular set of learning standards, students will not gain the critical

thinking, problem solving, creativity, and innovation skills necessary to succeed in the 21st century (Trilling & Fadel, 2009, pp. 96–97).

In this study, all the Grades 6–8 learning standards for mathematics in both the NJSLS and NJCCCS were analyzed and coded using Webb’s DOK methodology. Seventy-two percent (18% of DOK Level 1 and 54% of DOK level 2) of the Grades 6–8 mathematics NJSLS were rated at a DOK Level 1 and 2. Relatedly, 28% (24% of DOK 3 and 4% of DOK 4) of the Grades 6–8 mathematics NJSLS were rated at a depth-of-knowledge Level 3 and 4. This evidence suggests that the Grades 6–8 NJSLS in mathematics contain a vast majority (72%) of its standards falling in the lower recall (DOK Level 1) and skill/concept (DOK Level 2) categories. These results fall in contrast with the coding results of the Grades 6–8 NJCCCS in mathematics. The Grades 6–8 mathematics NJCCCS contain 60% (20% of DOK Level 1 and 40% of DOK Level 2) of its standards, which fall within lower levels of thinking (DOK Levels 1 and 2). Forty percent (27% of DOK Level 1 and 13% of DOK 2) of the Grades 6–8 mathematics NJCCCS require complex thinking found at DOK Levels 3 and 4.

In comparing these two sets of learning standards, it should be noted that the majority of learning standards within both the Grade 6–8 mathematics NJSLS (72%) and Grade 6–8 mathematics NJCCCS (60%) fall within the lower DOK Levels 1 or 2. However, the NJSLS possesses 12% more of its standards rated at these lower levels of complex thinking. Relatedly, the Grades 6–8 mathematics NJSLS contains fewer standards (28%) rated at higher levels of complex thinking in DOK Levels 3 or 4 compared to the Grade 6–8 mathematics NJCCCS that contained 40% of its learning standards at DOK Level 3 or 4. This represents a 12% advantage over the NJSLS in terms of providing potentially more opportunities to be exposed to curricula that includes deeper levels of complex thinking. The results of this study provide evidence that

New Jersey middle school students were provided with much deeper levels of complex thinking under the older math standards (NJCCCS) as compared to the newly adopted mathematics NJSLS for Grades 6–8.

This discovery of the superiority of the replaced Grade 6–8 mathematics NJCCCS in providing opportunities for complex thinking is monumental. Since its adoption in 2010, the Common Core State Standards (CCSS), which are the learning standards from which the NJSLS was originated have been touted as the solution for schools to ensure that students develop essential 21st century skills such as complex thinking. In turn, individual school districts revise curricula that best resembles the state-adopted standards, blindly accepting their credibility and superiority over other standards such as the replaced NJCCCS. The adoption of learning standards such as the NJSLS also influences other important educational elements such as the creation of textbooks by private corporations, course design, and teaching pedagogy. With so much attached to state-adopted learning standards, which have been shown to be inferior to a replaced set of learning standards at the middle school level, policymakers, bureaucrats, and district-level administrators should be alarmed regarding the quality of mathematics instruction currently being given to New Jersey’s middle school students and the cultivation of essential complex thinking skills. Such a realization insists on immediate discussion, review, and possible revision of current learning standards including its influence on school district curricula, policy, and classroom instruction.

### **Limitations**

Several limitations should be noted regarding this study. Although three coders were trained using Webb’s DOK coding protocol, the results are based on the coders’ experience and expertise. In addition, this study deviated from Webb’s recommendation of using at least five

coders. Three coders were utilized to increase efficiency and consistency, as a larger number of participants may detract from this goal. Furthermore, utilizing three coders for this study improved on other related studies that utilized only two coders.

This study was also limited to only the middle school grade levels of Grades 6–8 due to the lack of empirical evidence found at these levels. Also, the results of this study are limited to the instrument, Webb’s DOK framework, as no additional frameworks were utilized to conduct this research. Another limitation of this study was my decision to only analyze the standards and sub-standards in the Grades 6-8 math NJSLS and NJCCCS. No other grade level learning standards, subject area standards, or state standards were analyzed in my study. My study was also limited to comparing the cognitive complexity within the NJSLS to the previous learning standards of only one state, New Jersey.

### **Implications/Recommendations for Policy**

1. Return local control to school districts in order to provide students with a democratic education free from one-size-fits-all learning standards.

Trilling and Fadel (2009) found that students graduating at all levels, from schools to universities in the USA, lacked most of the skills, which are needed in today’s industries. These skills include critical thinking, problem solving, effective communication, creativity, innovation, leadership, professionalism and work ethic, teamwork and collaboration, working in diverse teams, project management, computing, information, and media literacies. This lapse is occurring while our changing economy demands students enter the work force with complex thinking skills including thinking creatively, critically, and strategically (Murnane & Levy, 2012). Businesses want workers who can make decisions, solve problems, engage in higher order thinking skills, and work collaboratively with others (Lehman, 1995, p. 2). Through initiatives

such as the NCLB Act and adoption of the Common Core State Standards, less local control over education resides with local school districts. McGuinn (2006) states that local control of school districts has decreased “to a degree unprecedented in the country’s history, and the federal government’s influence over education has never been greater” (p. 1). The idea of universal learning standards and national testing for education violates core principles of our democracy and expands the control and influence of the federal government over a local issue (Tienken & Canton, 2009, p. 3).

It is vital that policymakers recognize the importance of empowering local school districts to make curricula decisions based on their own high expectations for student learning, not top-down learning standards that ignore the individual needs and differences of students found throughout this diverse nation. Aikin’s (1942) Eight-Year Study already demonstrated that curriculum can be an entirely locally developed project and still produce better results than traditional standardized curricular programs (Tienken, 2011, p. 14, 2016). The use of learning standards imposed from outside the classroom, which do not take into account the expertise of local educators generally do not lead to better schools or a better education (Elwell, 1994, p. 343). A localized curriculum that is “closest to the taxpayers/consumers receiving them” could prove to be a more efficient and effective system of education (Koret Task Force, 2012, p. 5). Curriculum customized at the local level generally produces greater learning gains in students, as measured by standardized test scores and classroom assessments, than do standardized curricula developed distally from the students (Wang, Haertel, & Walberg, 1993). Although some observers state that centralized educational policies can increase school effectiveness, much evidence suggests that improvements occur when educators are given more responsibility, not less (Kirst, 1984). When educators are allowed more local control, they become more compatible

with neighborhood traditions, needs, and values (Cibulka, 1991). A curriculum that is developed at the local level must include the traditional subject content, but just as important, it will allow local curriculum developers to cater instruction to meet the diverse needs of the 21st century learner (Dewey, 1938; Howe & Meens, 2012).

2. Learn from the *Cardinal Principles of Secondary Education* (Commission on the Reorganization of Secondary Education, 1918) and remove one-size-fits- all standards mandates and replace with more holistic goals.

Schools need a comprehensive set of broad child-centered policies based on evidence, which embrace differentiation of implementation and foster cognitive diversity (Tienken, 2012). We must recall that education in the United States historically sought out to meet the needs of the individual above all else. This charge was strongly proclaimed in the *Cardinal Principles of Secondary Education* (Commission on the Reorganization of Secondary Education, 1918), “Individual differences in pupils and the varied needs of society alike demand that education be so varied as to touch the leading aspects occupational, civic, and leisure life” (p. 13). The authors of the *Cardinal Principles* called for educating all children through high school in the same system in an untracked, yet differentiated, curricular program. All students would participate in a curriculum that included the traditional subject matter (Tienken & Orlich, 2013, p. 15). Tienken and Orlich further remind us that the practices of differentiated instruction, differentiated curriculum, co-curricular activities, enrichment courses, exploratory electives, and specialized course sequences within one comprehensive high school were just some of the things that came out of the *Cardinal Principles of Secondary Education* and survive today in some places (p. 18). The most desirable education is one that enhances human curiosity and creativity, encourages risk taking, and cultivates the entrepreneurial spirit in the context of globalization (Zhao, 2012, p.

21). The results from the Eight-Year Study (Aikin, 1942) also demonstrated that public secondary schools can educate all students together; differentiate curriculum and instruction to meet their unique needs; diversify course offerings; operate in truly non-standardized democratic ways in which teachers, administrators, and university professors work together to solve problems; produce better results; and ultimately fill the role proposed by Thomas Jefferson and the other historic defenders of a democratic, classless education system (Tienken & Orlich, 2013, p. 27). Wang et al. (1993) found that proximal education variables, like locally developed curricula, directly influence student learning as compared to distal influences such as national learning standards and common testing.

The act of teaching to a test, which is the by-product of the national standards movement, discourages purposeful curricular customization and stifles children's creativity in schools. Standardized testing forces an emphasis on rote learning instead of critical, creative thinking and diminishes students' natural curiosity and joy for learning (Zhao, 2012, p. 18). If national reform is in order for education in the United States, it should look to replace nationally influenced learning standards with more holistic, student-centered goals. This approach is certainly stated in the *Cardinal Principals of Secondary Education* (Commission on the Reorganization of Secondary Education, 1918), which directs curriculum organization to be systematically planned with reference to the needs of the individual and society as a whole (p. 13). A holistic educational curriculum is echoed in Aikin's (1942) Eight-Year Study where college prescriptions were removed to give students the opportunity to focus more on personal growth and achievements.

The results of this study suggest that New Jersey's new standards, known as the New Jersey Student Learning Standards, are no more likely to result in developing students to be

complex thinkers than previous learning standards. In fact, this study reveals that the NJSLS could potentially decrease the opportunity for students to reach higher order thinking skills based on the lower cognitive complexity found throughout the mathematics Grade 6–8 NJSLS. Based on these findings, I recommend revisions be made to the NJSLS that include special considerations to add complex thinking into each learning standard. Curriculum activities for each learning standard can also be differentiated to include levels of cognitive complexity. In addition, I recommend policymakers empower local schools to take ownership of curricula and form their own high standards for student learning along with the appropriate local assessments to gauge progress and plan further instruction. “If American presidents and policy makers really want us to innovate and be competitive, then they should support the expansion of local control, not the submission of local control to a nationally directed system that is slow and lumbering” (Tienken & Orlich, 2013, p. 160). Unfortunately, no evidence exists of countries providing both a successful nationalized curriculum and a holistic education (Kohn, 2010). It is my desire that policymakers in the United States see the value and vision of education as those who authored the *Cardinal Principals of Secondary Education* (Commission on the Reorganization of Secondary Education, 1918) and take the necessary steps to unhinge local schools from fulfilling their true cause and potential.

3. State Boards of Education must take advantage of flexibilities offered in the Elementary and Secondary Education Act (ESSA) that support local control of curriculum decisions.

The Every Student Succeeds Act (ESSA, U.S. Department of Education, 2017) was signed by President Obama on December 10, 2010. This act reauthorized the Elementary and Secondary Education Act (ESEA), which was signed into law in 1965 by President Johnson. The



previous version of ESSA, the No Child Left Behind (NCLB) Act, was enacted in 2002. NCLB was scheduled for revision in 2007, but the requirements of the law became increasingly tedious for schools and educators. Recognizing this, the Obama administration set out to create a more flexible, workable law focused on preparing students for success in college and careers. This administration began granting flexibility to states involving specific requirements of NCLB in exchange for rigorous and comprehensive state-developed plans designed to close achievement gaps, increase equity, improve the quality of instruction, and increase outcomes for all students (U.S. DOE, 2017). This flexibility in ESSA fails to include flexibility in standardized testing requirements, as states are still required to test students in language arts and mathematics in Grades 3 through 8 and once in high school.

ESSA was passed with extensive support to empower the people best able to provide students with the education students deserve. “Students have never been well-served by rules, regulations, and red tape that are not absolutely necessary and that hinder their teachers, local school districts, and state leaders” (Kickbush, 2017, p. 1). According to Secretary of Education Betsy DeVos, states, along with local educators and parents, are the most crucial elements in ensuring that all students have access to a quality education (DeVos, 2017). Students depend on their states and local educators having the flexibility needed to better serve this endeavor. ESSA includes several key provisions including advancing equity for disadvantaged youth, providing vital data points to stakeholders as gathered through standardized assessments, supporting evidenced-based interventions developed at the local levels, expanding preschool offerings, and more. However, the most significant provision of the law is ESSA’s requirement that all students in America be taught to high academic learning standards that will adequately prepare them to succeed in college and careers. These learning standards must be considered “challenging,” and

individual states are being encouraged to explore and design superior learning standards that meet this requirement.

ESSA empowers state and local officials with the unique opportunity to take full ownership of designing and reviewing curricula. Presently, states can fully be compliant with Federal regulations while at the same time pursue action based on research in ensuring that adopted curricula instills the complex thinking so desperately required for college and career readiness. Through ESSA, educational stakeholders have been offered tremendous flexibility to pursue the endeavors that they view as vital in better serving students. With such additional flexibility comes additional responsibility on states to make curriculum review for the cultivation of complex thinking in students a true priority.

### **Implications/Recommendations for Practice**

1. School-level stakeholders must take on the responsibility of ensuring that local policy, curricula, and programs include complex thinking skills.

As the empirical evidence suggests in this study, the current New Jersey Student Learning Standards do not offer many opportunities for students to develop complex thinking skills as they interact with this specific set of learning standards. Given the importance of school personnel to offer opportunities for students to develop these skills, local stakeholders such as board of education members, administrators, and teachers must take full responsibility for implementing the necessary policies, curricula upgrades, and supplemental programs needed. A balance between state and local controls must be found that does not result in discouraging local control and ownership of student learning. School personnel should be encouraged to develop their own “distinctive characteristics” and still pursue common educational goals (Hadderman, 1988). The pursuit of common goals should not be so drastic that such an emphasis on common

learning standards, subject areas, and assessments result in the loss of individuality and loss of local control. Zhao (2012) states that in the pursuit of efficiency, equity, and national consistency, these learning standards and curricula essentially homogenize children's learning, serving the same educational diet within a nation (p. 11.) This quest for sameness and equality utilizing only a select group of disciplines such as language arts and mathematics results in a curriculum narrowing. Zhao explains that curriculum narrowing happens on two levels. First, when high stakes are attached to a limited number of subjects, they take precedence over other subjects. The second level happens when teachers and students teach and learn only what is likely to be tested, in the formats most likely presented on the tests (pp. 19–20).

To avoid such a disservice, local stakeholders such as board of education members must answer the call in ensuring that students are provided opportunities to think creatively, critically, and strategically. Instead of narrowly focusing on business affairs, these local boards must become assertive policymakers who direct their administrators to set high standards for academic excellence (Bell, 1988). In addition, local school boards can strengthen their roles by reviewing their own policies, clarifying their goals and practices, implementing procedures, undertaking more systematic training, and partnering with teacher and administrator organizations to influence state education policies, rather than react to state-generated proposals (Hadderman, 1988). Local school board members must empower the educators committed to the school district in designing and implementing relevant curricula that provides opportunities for developing students as complex thinkers and problem solvers. Teachers, along with their administrators, are the best informed group of educators in our nation's history and deserve to be entrusted to carry out such a vital task (Elwell, 1994). Local school board members can also be influential in connecting their schools to beneficial business partnerships with a vested interest in

adequately training the next generation of employees and entrepreneurs. The overarching idea is that partnerships serve a full range of functions and should not be limited to just educational institutions. In some sense, partners can be considered an extended campus (Zhao, 2012). Finally, local school boards must financially support established curricula, supplemental programs, and related teacher trainings required for developing students as complex thinkers as the school board works to construct annual school budgets that support the various needs throughout the school district.

2. School level administrators must infuse complex thinking into all parts of the curriculum and school culture.

Dewey (1902) proposed that the learner gains knowledge and constructs meaning from the interaction between his or her own experiences and ideas that he or she comes into contact with. Kolb (1984) developed the experiential learning theory based in part on Dewey's work, as a process whereby knowledge is created through the transformation of experience by applying the four steps of experiencing, reflecting, thinking, and acting in a highly iterative manner. As Dewey (1938) acknowledged, practical experience is an important component of effective learning. There is an intimate and necessary relation between the processes of personal experiences and education. Aikin's (1942) publication of the landmark Eight-Year Study emphasized five critical principles essential in the development of complex thinking: (1) strong emphasis on the student, (2) personal experiences, (3) different development styles, (4) problem solving and making prior knowledge connections, and (5) the ability to approach problems through many different lenses. Writing about the learning experience, Zhao (2012) proclaims:

Some experiences enhance our creativity, while others suppress it. Some experiences encourage risk taking, while others make us risk averse. Some

experiences strengthen our desire to ask questions, while others instill compliance. Some experiences foster a mindset of challenging the status quo, while others teach us to follow orders. Human beings are adaptable and our nature malleable. The experiences we have play a significant role in what we become. Schools are the primary institution for our children besides family, and therefore the primary place that shapes the experiences our children have. (p. 12)

With schools playing such a vital role in orchestrating the learning experiences of students, the proper planning of learning pathways also known as curriculum writing becomes even more essential for the 21st century school district. To succeed in the 21st century, an educated person must possess complex thinking skills that enable him or her to think logically and to solve problems effectively (Kivunja, 2014, p. 85). Trilling and Fadel (2009) suggest that educators can teach our students critical thinking by encouraging them to use inductive and deductive reasoning, getting them to analyze parts of a whole so they engage in systems thinking, teaching them to make judgments as a result of analysis, interpretation, reflection and evaluation. McCain (2007) recommends a four step-by-step process that we should teach our students before they leave school to enable them solve problems they will face in the real world after school. McCain refers to the process as the 4Ds of Problem Solving and are summarized as follows:

1. Define the problem envisioned before starting work at it.
2. Design a plan for the solution of the conceptualized problem. This involves
  - (a) developing a plan to make the idea a reality,
  - (b) developing and learning the skills and knowledge needed to solve the problem,

(c) breaking the problem into logical sequences of smaller sub-tasks that are easier to tackle, and

(d) deciding on resources needed to solve the problem.

3. Do tackle the problem. This involves putting the plan into action to solve the problem.

4. Debrief. This involves reviewing how well you have accomplished what you set out to do. That is, how successful have you been in solving the problem?

In order to provide effective educational preparation for students built upon experiential learning, school administrators need to begin with the review and revision of current curricula to ensure the inclusion of vital complex thinking skills. As the process of curriculum writing at the local school level generally involves both school administrators and teachers, professional development should be provided to train curriculum writers on utilizing Webb et al's (2005) depth of knowledge to describe the complex thinking represented across all curricula and lesson objectives.

Recognizing the results of this study and similar studies that suggest the lack of complex thinking currently found within the New Jersey Student Learning Standards, school personnel should adapt and supplement their intended curricula in order to provide opportunities for students to develop complex thinking skills. Webb's DOK should also be utilized by teachers and administrators to evaluate the enacted curricula, daily lessons, questioning strategies, and other forms of assessment. Principals are especially important to this process as they are being given increased authority for the allocation of resources in many schools, including increased control of the curriculum (Lehman, 1995).

Regarding the enacted curriculum, principals also set the level of expectations for

teaching performance as they provide feedback during formal and informal observations, discuss content and resources at team meetings, and communicate both in person and electronically. A principal with the goal of increasing opportunities for complex thinking in students must take the time and effort to enlighten staff to the needs and benefits of these skills.

Given the layered format of the learning standards found within the New Jersey Student Learning Standards, it is essential that curriculum teams work to dissect each standard into smaller, more manageable parts. Tienken (2013) calls this dissection of learning standards curriculum customization with the goal of unpacking standards into their component parts in order to scaffold and customize content for students. These teams at the local level work to dissect each learning standard and break it into specific learning objectives in order to understand more fully what students must master and how to best organize the content (pp. 9–10). After dissecting the learning standards into teachable parts, educators need to connect the curriculum objectives to the students, bringing connection and the use of knowledge and skills to solve problems in authentic situations. Sulla (2011) states that teachers in classrooms must masterfully craft learning experiences that emanate from authentic problem situations. Teachers are facilitators of learning, ensuring that students achieve at the highest levels (p. 1). Students can do more and remember more when the content makes sense and has meaning to them. Content not connected to the experiences and needs of the students subjected to that content is irrelevant and counterproductive (Tienken & Orlich, 2013, p. 155).

In order to provide students with opportunities to develop complex thinking skills within authentic learning situations, curricular teams should consider the incorporation of

problem-based learning methodologies into curricula planning and execution. Brown and Kuratko (2015) state that to teach innovatively, one must abstain from teaching abstract concepts detached from concrete problems and focus on applying instruction to real-world situations (p. 148). This focus captures the purpose and definition of project-based learning (PBL). Project-based learning is a teaching and learning method in which students engage a problem without preparatory study and with knowledge insufficient to solve the problem, requiring these students to extend and apply existing knowledge and understanding to generate a solution (Wirkala & Kuhn, 2011, p. 1157). Problem-based learning is well suited to assist students in becoming active learners because it situates learning in real-world problems and makes students responsible for their learning. Educators are interested in problem-based learning because of its emphasis on active, transferable learning and its potential for motivating students (Hmelo-Silver, 2004, p. 236). According to Barrows and Kelson (1995), problem-based learning was designed with several important goals designed to assist students:

1. construct an extensive and flexible knowledge base;
2. develop effective problem-solving skills;
3. develop self-directed, lifelong learning skills;
4. become effective collaborators; and
5. become intrinsically motivated to learn.

Good problem-based learning instruction requires carefully designed instructional protocols, including well-designed scaffolding during each stage of the process (Davies, 2000). The problem-based learning facilitator guides the development of complex thinking skills by encouraging students to justify their thinking and externalizes self-



reflection by directing appropriate questions to individuals (Hmelo-Silver, 2004, p. 245). Results from several studies (Gallagher & Stepien, 1996; Schwartz & Bransford, 1998; Wirkala & Kuhn, 2011) suggest that students instructed utilizing problem-based methodologies have demonstrated stronger performances than comparative groups instructed in more traditional teaching methodologies. The problem-based curriculum has been demonstrated to be superior to traditional forms and needs to be returned to the classroom, through local development (Tienken & Orlich, 2013, p. 156). Those administrators interested in exploring the many problem-based learning resources available to schools should consider [www.definedstem.com](http://www.definedstem.com), [www.idecorp.org](http://www.idecorp.org), and [www.bie.org](http://www.bie.org).

School districts in the early stages of adopting problem-based learning strategies should consider exploring two current educational trends that further equip students to pursue passions, think creatively, and problem solve. The first trend that grew from Google is genius hour. Google employees are able to spend up to 20% of their time working on projects in which the employees are interested (Heick, 2014). Several notable Google products were created during such exploratory time. This corporate trend has made its way into schools in the form of genius hour. Genius hour is an approach to learning built around student curiosity, self-directed learning, and passion-based work. Genius hour is a movement that allows students to explore their own passions and encourages creativity in the classroom. This approach gives students control of what they study, how they study it, and what they do within a defined time period of the school week (Heick, 2014). During a typical genius hour project, students are challenged to explore something they are curious about and spend several weeks exploring the topic.

The culminating event after this exploration is usually in the form of a presentation/project that is shared with others. The teacher acts as a facilitator to learning in this process, guiding and assisting students during this self-directed learning approach.

Another trend is the makerspace movement that involves the dedication of a specific space to “tinkering” and “making” within a school building. Makerspaces provide hands-on, creative ways to encourage students to design, experiment, build, and invent as they engage in science, engineering, and problem solving (Cooper, 2013). A range of activities for makerspaces might include cardboard construction, woodworking, electronics, robotics, digital fabrication, and others. These spaces are helping to prepare students with 21st century skills in the fields of science, technology, engineering, and mathematics (STEM). Makerspaces also foster entrepreneurship and are being utilized as accelerators for business startups (see [www.makerspaces.com](http://www.makerspaces.com)).

### **Recommendations for Further Research**

Fowler (2013) describes the policy process as the sequence of events that occurs when a political system considers different approaches to public problems, adopts one of them, tries it out, and evaluates it (p. 14). It is sought through the results of this study that the state of New Jersey and others could begin a discussion on the appropriateness of the newly adopted NJSLS and other related sets of learning standards such as the CCSS at the local, state, and national levels. The intent of this study was to start a debate on the appropriateness of a nationally adopted curriculum and to provide empirical evidence on how the NJSLS and NJCCCS middle school mathematics standards compare as a catalyst for complex thinking. Based on the results of this study, I recommend further evaluation and modification to the NJSLS in order to further improve the potential for complex thinking within this specific set of mathematics standards.

This task force is encouraged to use other sets of learning standards such as the NJCCCS, which were found to possess higher levels of strategic and extended thinking as exemplars for refining the current NJSLS.

This task force, which should include practicing administrators and educators in the field, would determine if the current NJSLS should be abandoned for a new set of learning standards or modified to include more potential for complex thinking. It is my recommendation that the State of New Jersey work to modify its current set of learning standards along with a calculated plan of action including the funding of supplemental programs, training, and materials for teachers that enable students to reach higher levels of complex thinking. Individual school districts should also support such training along with a critical review of curriculum with the proper lens of increasing complex thinking across all subject areas.

In addition to the aforementioned task force work, further research comparing the distribution of cognitive complexity within various sets of learning should be conducted in the language arts and mathematics areas at the elementary grade levels, which have not yet been evaluated in New Jersey. The learning standards of states other than New Jersey should also be evaluated in order to expand the research in the field and to compare these findings to those presented in this particular study. The replication of this study or other related studies could also be conducted utilizing a different conceptual framework than Webb's framework, such as the use of Hess's cognitive rigor matrix. Finally, further research could analyze the assessed curriculum through the lens of a specific conceptual framework such as Webb et al's (2005) depth of knowledge or cognitive rigor matrix (Hess, Carlock,, Jones, & Walkup, 2009).

## **Conclusion**

The intent of this study was to determine if deeper levels of complex thinking were found within both the Grades 6–8 mathematics NJSLS and NJCCCS; and if so, how much was contained within each set of learning standards. This study proves that, overall, New Jersey’s previous Grades 6–8 mathematics NJCCCS provided more opportunities for complex thinking when compared to the newly adopted Grades 6–8 mathematics NJSLS. Although these findings can and should alarm New Jersey’s educators, it is my hope that this research will spark responsible conversations at both the state and local levels regarding the meaning of 21st century learning, the use of Webb’s DOK for assessing the intended/enacted curriculum, and the importance of incorporating complex thinking skills on a wide scale into New Jersey’s school curriculum. It is imperative that local and state education leaders come together and develop a plan of action regarding the review and revision of the NJSLS. We cannot accept learning standards touted as the recipe for ensuring that students are college and career ready while further analysis reveals much less. We must also remember our historical founding upon documents such as the *Cardinal Principles of Secondary Education* (Commission on the Reorganization of Secondary Education, 1918) and the Eight-Year Study (Aikin, 1942) that direct us to a democratic, all-inclusive, student-centered education where students are seen as active participants in the learning process. There must be a fusion of subject matter with the student, and the student must be viewed as an active constructor of meaning who brings prior knowledge and experience to the learning environment; that prior knowledge and experience must be used as a springboard and connection to the new material (Dewey, 1938; Tienken & Orlich, 2013). Those who care about the democratic future of children need to examine their ideas and be willing to acknowledge that perhaps they hold beliefs born from worn-out slogans and dogmas (Tienken & Orlich, 2013, p. 166). Local schools cannot be passive in their efforts to

positively influence state educational policy to avoid standardization to the degree that it impedes a well-rounded, student-centered education. In the same way, local schools must harness the powers they have to evaluate and infuse complex thinking skills into all elements of the intended curriculum as well as bring complex thinking to the forefront of teacher and administrator focus. Only when we provide our students with these opportunities for developing complex thinking skills will we be truly cultivating a generation that is college and career ready.

## References

- Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2015). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research*, 85, 275–314.
- Aikin, W. M. (1942). *The story of the eight-year study: With conclusions and recommendations*. New York, NY: Harper & Bros.
- Anderson, L. W., & Krathwohl, D. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York, NY: Longman.
- Anthanassiou, N., McNett, J. M., & Harvey, C. (2003) Critical thinking in the management classroom: Bloom's taxonomy as a learning tool. *Journal of Management Education*, 27(5), 533–555. doi:10.1177/1052562903252515
- Azzam, A. M. (2009). Why creativity now? A conversation with Sir Ken Robinson. *Educational Leadership*, 67(1), 22–36.
- Baloch, Q. B., & Inam, M. (2007). Strategic thinking: Catalyst to competitive advantage. *Journal of Managerial Sciences*, 1(2), 1–26. Retrieved from [www.qurtuba.edu.pk/jms/default\\_files/JMS/1\\_2/1\\_qadar.pdf](http://www.qurtuba.edu.pk/jms/default_files/JMS/1_2/1_qadar.pdf)
- Barrington, L., Casner-Lotto, J., & Partnership for 21st Century Skills. (2006). Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century U.S. workforce. *Partnership for 21st Century Skills*. Retrieved from <http://files.eric.ed.gov/fulltext/ED519465.pdf>
- Barrows, H., & Kelson, A. C. (1995). *Problem-based learning in secondary schools and the problem-based learning institute* (Monograph 1). Springfield, IL: Problem-Based Learning Institute.
- Beghetto, R. A. (2007). Does creativity have a place in classroom discussions? Teachers' response preferences. *Thinking Skills and Creativity*, 2(1), 1–9.
- Bell, L., & Schniedewind, N. (1989). Realizing the promise of humanistic education: A reconstructed pedagogy for personal and social change. *Journal of Humanistic Psychology*, 29(2), 200–223.
- Bell, T. H. (1988). Parting the 13th man. *Phi Delta Kappan*, 69, 400–407.
- Berelson, B. (1952). *Content analysis in communication research*. Glencoe, IL: The Free Press.

- Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M. & Rumble, M. (2011). Defining twenty first century skills. In P. Griffin, B. McGaw, & E. Care (Eds.), *Assessment and teaching of 21st century skills* (pp. 17–66). New York: Springer.
- Blank, R. K., Porter, A., & Smithson, S. (2001). *New tools for analyzing teaching, curriculum and standards in mathematics and science*. Report from Survey of Enacted Curriculum Project (National Science Foundation REC98-03080). Washington, DC: Council of Chief State School Officers.
- Bloom, B., Englehart, M. Furst, E., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals*. Handbook I: Cognitive domain. New York, Toronto: Longmans, Green.
- Bogdan, R. C., & Biklen, S. K. (2014). *Research for education: An introduction to theories and methods*. Upper Saddle River, NJ: Pearson Education.
- Brown, T. J., & Kuratko, D. F. (2015). The impact of design and innovation on the future of education. *Psychology of Aesthetics, Creativity, and the Arts*, 9(2), 147–151.
- Burnard, P. (2006). Reflecting on the creativity agenda in education. *Cambridge Journal of Education*, 36, 313–318. doi:10.1080/03057640600865801
- Carruthers, P. (2002). Human creativity. *British Journal of the Philosophy of Science*, 53, 225–249.
- Celuch, K., & Slama, M. (1999). Teaching critical thinking skills for the 21st century: An advertising principles case study. *Journal of Education for Business*, 74(3), 134–139. doi:10.1080/08832329909601675
- Chi, Y., Garcia, R. B., Surber, C., & Trautman, L. (2011). *Alignment study between the Common Core State Standards in English Language Arts and Mathematics and the WIDA English Language Proficiency Standards: Pre-kindergarten through Grade 12 (2007 ed.)*. Norman, OK: University of Oklahoma College of Continuing Education. ETEAM.
- Cibulka, J. (1991). *The politics of urban education in the United States: The Politics of Education Association Yearbook*. Ellanwood, GA: Falmer Press.
- CISCO Systems. (2008). *Equipping every learner for the 21st century*. Retrieved from [http://www.cisco.com/c/dam/en\\_us/about/citizenship/socio-economic/docs/GlobalEdWP.pdf](http://www.cisco.com/c/dam/en_us/about/citizenship/socio-economic/docs/GlobalEdWP.pdf)
- Clark, A. (2016, May 4). N.J. revises, renames common core academic standards. *The Star Ledger*. Retrieved from [http://www.nj.com/education/2016/05/nj\\_common\\_core\\_standards\\_christie.html](http://www.nj.com/education/2016/05/nj_common_core_standards_christie.html)

- Cohen, S., & Hersh, R. (1972). Behaviorism and humanism: A synthesis for teacher education. *The Journal for Teacher Education*, 23(2), 172–176.
- Commission on the Reorganization of Secondary Education. (1918). *Cardinal principles of secondary education*. Washington, DC: U.S. Government Printing Office. (ERIC Document Reproduction Service No. ED541063)
- Common Core State Standards Initiative. (2017). *What parents should know*. Retrieved from <http://www.corestandards.org/what-parents-should-know/>
- Cooper, J. (2013). *Designing a school makerspace*. Retrieved from <https://www.edutopia.org/blog/designing-a-school-makerspace-jennifer-cooper>
- Council of Chief State School Officials. (2017). *College and career-ready standards*. Retrieved from [http://ccsso.org/Resources/Programs/College-\\_and\\_Career-Ready\\_Standards.html](http://ccsso.org/Resources/Programs/College-_and_Career-Ready_Standards.html)
- Covington, M. (1968). Promoting creative thinking in the classroom. *The Journal of Experimental Education*, 37(1), 22–30.
- CPALMS. (2014). *Content complexity Florida standards*. Retrieved from [http://www.cpalms.org/Uploads/docs/CPALMS/initiatives/contentcomplexity/CPALMS\\_ccdefinitions\\_140711.pdf](http://www.cpalms.org/Uploads/docs/CPALMS/initiatives/contentcomplexity/CPALMS_ccdefinitions_140711.pdf)
- Creswell, J. W. (2007). *Qualitative inquiry and research design* (2nd ed.). Thousand Oaks, CA: Sage.
- Cross, J. S., & Nagle, J. M. (1969). Helping teachers to improve students' thinking skills. *NASSP Bulletin*, 53, 65–79. doi: 10.1177/019263656905333509
- Davies, P. (2000). Approaches to evidence-based teaching. *Medical Teacher*, 22(1), 14–21.
- DeVos, B. (2017). *Key policy letters signed by the education secretary or deputy secretary*. Retrieved from <https://www2.ed.gov/policy/elsec/guid/secletter/170313.html>
- Dewey, J. (1902). *The child and the curriculum*. Chicago, IL: University of Chicago Press.
- Dewey, J. (1933). *How we think*. New York, NY: D. C. Heath and Company.
- Dewey, J. (1938). *Experience and education*. New York, NY: Simon & Schuster.
- Donovan, L., Green, T., & Mason, C. (2014). Examining the 21st century classroom: Developing an innovation configuration map. *Educational Computing Research*, 50(2), 161–178.
- Elder, L., & Paul, R. (2006). Critical thinking: The nature of critical and creative thought. *Journal of Developmental Education*, 30(3), 34–35.



- Elder, L., & Paul, R. (2007). Critical thinking: The nature of critical and creative thought, Part II. *Journal of Developmental Education*, 30(3), 36–37.
- Elo, S., Kaariainen, M., Kanste, O., Polkki, T., Utriainen, K., & Kyngas, H. (2014). Qualitative content analysis: A focus on trustworthiness. *SAGE Open*, January – March, 1–10, doi: 10.1177/2158244014522633
- Elwell, W. C. (1994). Let teachers develop the curriculum. *Clearing House*, 67(6), 343–344.
- Ennis, R. (1985). A logical basis for measuring critical thinking skills. *Educational Leadership*, 43(2), 44–48.
- Ennis, R. (1987). A taxonomy of critical thinking dispositions and abilities. In J. Baron & R. Sternberg (Eds.), *Teaching thinking skills: Theory and practice* (pp. 9–26). New York, NY: Freeman.
- Ernst & Young. (2010). *Connecting innovation to profit: Five key insights from the world's leading entrepreneurs*. Retrieved from <http://www.ey.com/US/en/Services/Strategic-Growth-Markets/Connecting-innovation-to-profit---Five-insights-from-leading-entrepreneurs>
- Ewing Marion Kauffman Foundation. (2007). *On the road to an entrepreneurial economy: A research and policy guide*. Kansas City, MO: Author.
- Facione, P. A., Facione, N. C., & Giancarlo, C. F. (1996). The motivation to think in working and learning. *New Directions for Higher Education*, 96, 67–79. doi:10.1002/he.36919969608
- Florida State University. (2013). *CPALMS*. Retrieved from <http://www.cpalms.or/Downloads.aspx>
- Fowler, F. C. (2013). *Policy studies for educational leaders: An introduction*. Boston: Pearson.
- Gallagher, S., & Stepien, W. (1996). Content acquisition in problem-based learning: Depth versus breadth in American studies. *Journal for the Education of the Gifted*, 19, 257–275.
- Gardiner, G. S. (1972). Complexity training and prejudice reduction. *Journal of Applied Social Psychology*, 2, 326–342. doi:10.1111/j.1559-1816.1972.tb01284.x
- Gardner, N. S., & Powell, R. (2014). The Common Core is a change for the better. *Phi Delta Kappan*, 95(4), 49–53. doi: 10.1177/003172171309500411
- Geertsen, H. R. (2003). Rethinking thinking about higher level thinking. *Teaching Sociology*, 31(1), 1–19.

- Glaser, E. M. (1985). Critical thinking: Education for responsible citizenship. *National Forum*, 65, 24–27.
- Glaveanu, V. P. (2011). Children and creativity: A most unlikely pair. *Thinking Skills and Creativity*, 6, 122–131.
- Hadderman, M. L. (1988). *State vs. local control of schools*. ERIC Digest Series Number 24. ERIC Clearinghouse on Educational Management. Retrieved from <http://files.eric.ed.gov/fulltext/ED291164.pdf>
- Hammershøj, L. G. (2013). Creativity in education as a question of cultivating sensuous forces. *Thinking Skills and Creativity*, 13, 168–182. doi:10.1016/j.tsc.2014.05.003
- Haycock, K., Cheadle, A., & Bluestone, K. S. (2012). Strategic thinking: Lessons for leadership from the literature. *Library Leadership & Management*, 26(3/4), 1–23. Retrieved from <https://journals.tdl.org/llm/index.php/llm/article/download/2635/6096>
- Heick, T. (2014). *6 principals of genius hour in the classroom*. Retrieved from <http://www.teachthought.com/learning/6-principles-of-genius-hour-in-the-classroom/>
- Heracleous, L. (1998). Strategic thinking or strategic planning? *Long Range Planning*, 31(3), 481–487. Retrieved from [www.heracleous.org/uploads/1/1/2/9/.../lrp\\_98\\_-\\_strat\\_thinking.pdf](http://www.heracleous.org/uploads/1/1/2/9/.../lrp_98_-_strat_thinking.pdf)
- Herrmann-Nedhi, A. (1998). *Creativity and strategic thinking: The coming competencies*. Herrmann International, 1–6. Retrieved from [http://www.herrmansolutions.com/article\\_creativity-and-strategic-thinking\\_competencies/](http://www.herrmansolutions.com/article_creativity-and-strategic-thinking_competencies/)
- Hess, K. (2013). *A guide for using Webb's depth of knowledge with common core state standards*. The Common Core Institute. Retrieved from <http://cliu21cng.wikispaces.com/file/view/WebsDepthofKnowledgeFlipChart.pdf/457670878/WebsDepthofKnowledgeFlipChart.pdf>
- Hess, K., Carlock, D., Jones, B., & Walkup, J. R. (2009). *What exactly do "fewer, clearer, and higher standards" really look like in the classroom? Using a cognitive rigor matrix to analyze curriculum, plan lessons, and implement assessments*. Retrieved from <http://schools.nyc.gov/NR/rdonlyres/D106125F-FFF0-420E-86D9-254761638C6F/0/HessArticle.pdf>
- Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn. *Educational Psychology Review*, 16(3), 235–266.
- Howe, K. R., & Meens, D. (2012). *Democracy left behind: How recent education reforms undermine local school governance and democratic education*. Boulder, CO: National

- Policy Education Center. Retrieved from <http://nepc.colorado.edu/publication/democracy-left-behind>
- Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15(9), 1277–1288.
- Hunter, E. (1991). Focus on critical thinking skills across the curriculum. *NASSP Bulletin*, 75, 72–76. doi:10.1177/019263659107553208
- International Assembly for Collegiate Business Education. (2016). *Bloom's taxonomy of educational objectives and writing intended learning outcomes statements*. Retrieved from <http://iacbe.org/pdf/blooms-taxonomy.pdf>
- International Business Machines. (2012). *Leading through connections: Insights from the global chief executive officer study*. Retrieved from [http://www935.ibm.com/services/multimedia/anz\\_ceo\\_study\\_2012.pdf](http://www935.ibm.com/services/multimedia/anz_ceo_study_2012.pdf)
- Kanevsky, L. (2016). *Complex thinking. Possibilities for learning*. Retrieved from [http://possibilitiesforlearning.com/?page\\_id=406](http://possibilitiesforlearning.com/?page_id=406)
- Kay, K. (2009). Middle schools preparing young people for 21st century life and work. *Middle School Journal*, 40(5), 41–45. Retrieved from <http://cesa7ita2009.pbworks.com/f/middle+schools+preparing+young+people+for+work+in+the+21st+century.pdf>
- Kern, D. (2014). Common Core-less? A critical review of the common core state standards research. *The New England Reading Association*, 50(1), 75–77.
- Kettler, T. (2014). Critical thinking skills among elementary school students: Comparing identified gifted and general education student performance. *Gifted Child Quarterly*, 58(2), 127–136. doi:10.1177/0016986214522508
- Kickbush, P. (2017). *ESSA consolidated state template –FAQs*. Retrieved from [www2.ed.gov/documents/press-releases/essa-consolidated-state-template-faqs.doc](http://www2.ed.gov/documents/press-releases/essa-consolidated-state-template-faqs.doc)
- Kivunja, C. (2014). Do you want your students to be job-ready with 21st century skills? Change pedagogies: A paradigm shift from Vygotskyian social constructivism to critical thinking, problem solving and Siemens' digital connectivism. *International Journal of Higher Education*, 3(3), 81–91.
- Kirst, M. W. (1984). Local control—The vanishing myth in Texas. *Phi Delta Kappan*, 66, 192–195.
- Kohn, A. (2010). Debunking the case for national standards. *Education Week*, 29(17), 28–30.

- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.
- Koret Task Force on K–12 Education. (2012, February). *Choice and federalism: Defining the federal role in education*. Retrieved from [www.choiceandfederalism.org](http://www.choiceandfederalism.org)
- Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory Into Practice*, 41(4), 212–218.
- Kyllonen, P. C. (2012, May). *Measurement of 21st century skills within the Common Core State Standards*. Paper presented at the K–12 Center at ETS Invitational Research Symposium on Technology Enhanced Assessments. Atlanta, GA. Retrieved from <http://www.k12center.org/rsc/pdf/sessions5-kyllonen-paper-tea2012.pdf>
- Lee, K. (2007). Online collaborative case study learning. *Journal of College Reading and Learning*, 37(2), 82–100.
- Lehman, P. R. (1995). Control of K–12 arts education: Who sets the curriculum? *Arts Education Policy Review*, 97(2), 1–16.
- Levin, H. M. in Seymour, M. (2004). *Educating for humanity: Rethinking the purposes of education*. London, UK: Paradigm Publishers.
- Lewis, A., & Smith, D. (1993). Defining higher order thinking skills. *Theory Into Practice*, 32(3), 131–137.
- Lewy, A., & Bathory, Z. (1994). The taxonomy of educational objectives in continental Europe, the Mediterranean, and the Middle East. In L. W. Anderson & L. A. Sosniak (Eds.), *Bloom's taxonomy: A forty-year retrospective* (pp. 174–189). Chicago, IL: University of Chicago Press.
- Liedtka, J. M. (1998). Strategic thinking: Can it be taught? *Long Range Planning*, 31(1), 120–129. Retrieved from [http://www.egovernment.tas.gov.au/\\_\\_data/assets/pdf\\_file/0012/121125/6Liedtka.PDF](http://www.egovernment.tas.gov.au/__data/assets/pdf_file/0012/121125/6Liedtka.PDF)
- Lin, Y. S. (2010). Drama and possibility thinking: Taiwanese pupils' perspectives regarding creative pedagogy in drama. *Thinking Skills and Creativity*, 5, 108–119.
- Lizarraga, M. L., Baquendano, M. T., & Oliver, M.S. (2010). Psychological intervention in thinking skills with primary education students. *School Psychology International*, 31(2), 131–145.
- Longo, C. (2010). Fostering creativity or teaching to the test? Implications of state testing on the delivery of science instruction. *Clearing House*, 83(2), 54–57.  
doi:10.1080/00098650903505399

- March, J. K., & Peters, K. H. (2015). Telling the truth about the Common Core. *Phi Delta Kappan*, 96(8), 63–65. doi:10.1177/0031721715583966
- Mayer, R. E. (2002). Rote versus meaningful learning. *Theory Into Practice*, 41(4), 226–232.
- Mayring, P. (2000). Qualitative content analysis. *Qualitative Social Research*, 1(2). Retrieved from <http://www.qualitative-research.net/index.php/fqs/article/view/1089/2385>
- McCain, T. (2007). *Teaching for tomorrow: Teaching content and problem-solving skills*. Thousand Oaks, CA: Corwin.
- McDonnell, L. M. (2012). Educational accountability and policy feedback. *Educational Policy*, 27(2), 170–189. doi 10.1177/0895904812465119
- McGuinn, P. J. (2006). *No Child Left Behind and the transformation of federal education policy, 1965–2005*. Lawrence, KS: University Press of Kansas.
- McLaughlin, M. (1992). Employability skills profile: What are employers looking for? (Report 81-92-E0). Ottawa, Canada: Conference Board of Canada.
- Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass.
- Mintzberg, H. (1994). The fall and rise of strategic planning. *Harvard Business Review*. January-February issue. Retrieved from <https://hbr.org/1994/01/the-fall-and-rise-of-strategic-planning>
- Miri, B., David, B., & Uri, Z. (2007). Purposely teaching for the promotion of higher order thinking skills: A case of critical thinking. *Research in Science Education*, 37(4), 353–369. Retrieved from <http://eric.ed.gov/?id=EJ774448>
- Mouter, N., & Vonk Noordegraaf, D. (2012). *Intercoder reliability for qualitative research: You win some, but do you lose some as well?* TRAIL Research School. Retrieved from [http://rstrail.nl/new/wp-content/uploads/2015/02/mouter\\_-\\_vonk\\_noordegraaf\\_2012.pdf](http://rstrail.nl/new/wp-content/uploads/2015/02/mouter_-_vonk_noordegraaf_2012.pdf)
- Murnane, R. J., & Levy, F. (2012). *The New Division of Labor: How Computers Are Creating the Next Job Market*. Princeton University Press.
- New Jersey Department of Education, College and Career Readiness Task Force. (2012). *Final Report of the New Jersey Department of Education College and Career Readiness Task Force*. Retrieved from <http://www.state.nj.us/education/genfo/readiness.pdf>
- New Jersey Department of Education. (2004). The New Jersey Core Curriculum Content Standards. Retrieved from <http://www.state.nj.us/education/cccs/2004/cccs.pdf>

- New Jersey Department of Education. (2017). The New Jersey Student Learning Standards. Retrieved from <http://www.state.nj.us/education/cccs/>
- Newmann, F. M. (1988). Higher order thinking in the high school curriculum. *NASSP Bulletin*, 72, 58–64. doi: 10.1177/019263658807250812
- Newmann, F. M. (1990). Higher order thinking in teaching social studies: A rationale for the assessment of classroom thoughtfulness. *Journal of Curriculum Studies*, 22, 41–56.
- Newmann, F. M., Lopez, G., & Byrk, A.S. (1998). *The quality of intellectual work in Chicago schools: A baseline report*. Chicago, IL: Consortium on Chicago School Research.
- Newton, L. D., & Newton, D. P. (2014). Creativity in 21st-century education. *Prospects: Quarterly Review of Comparative Education*, 44(4), 575–589.
- Niebling, B. C. (2012). *Determining the cognitive complexity of the Iowa Core in Literacy and Mathematics: Implications and applications for curriculum alignment*. Des Moines, IA: Iowa Department of Education. Retrieved from [http://www.educateiowa.gov/index.php?option=com\\_docman&task=doc\\_download&gid=14524&Itemid=5111](http://www.educateiowa.gov/index.php?option=com_docman&task=doc_download&gid=14524&Itemid=5111)
- O'Shannassy, T. (1999). *Strategic thinking: A continuum of views and conceptualization*. RMIT Business. Retrieved from <http://mams.rmit.edu.au/5rbhieqtd5o.pdf>
- Partnership for 21st Century Skills. (2016). *Framework for 21<sup>st</sup> Century Learning*. Retrieved from <http://www.p21.org/about-us/p21-framework>
- Peery, A. B. (2013). Reading for the future: How the Common Core will change instruction. *The New England Reading Association*, 48(2), 1–8.
- Phillips, V., & Wong, C. (2012). Teaching to the common core by design not accident. *Phi Delta Kappan*, 93, 31–37.
- Pogrow, S. (2015). *Authentic quantitative analysis for educational leadership, decision making, and EdD dissertations*. United States of America: NCPEA Publications.
- Porter, A., McMaken, J., & Yang, R. (2011). Common Core Standards: The new U.S. intended curriculum. *Educational Researcher*, 40(3), 103–116. doi: 10.3102/0013189X11405038
- Posner, D. (2002). Education for the 21st century. *Phi Delta Kappan*, 84(4), 316–317. Retrieved from [http://bcsbestyearever.weebly.com/uploads/3/7/7/2/37728865/education\\_for\\_the\\_21st\\_century.pdf](http://bcsbestyearever.weebly.com/uploads/3/7/7/2/37728865/education_for_the_21st_century.pdf)
- Rhodes, T. (Ed.). (2010). *Assessing outcomes and improving achievement: Tips and tools for using rubrics*. Washington, DC: Association of American Colleges and Universities.

- Rodd, J. (1999). Encouraging young children's critical and creative thinking skills. *Childhood Education*, 75(6), 350–353.
- Rogers, C. (1970). Toward a theory of creativity. In P. Vernon (Ed.), *Creativity: Selected readings* (pp. 137–151), Hammondsworth, London: Penguin Books.
- Rotherham, A. J., & Willingham, D. T. (2010). '21st-century' skills: Not new, but a worthy challenge. *American Educator*, 34(1), 17.
- Runco, M. A. (2008). Creativity and education. *New Horizons in Education*, 56(1), 96–104.
- Saavedra, A. R., & Opfer, V. D. (2012). Learning 21st century skills requires 21st century teaching. *Phi Delta Kappan*, 94(2), 8–13. doi:10.1177/003172171209400203
- Sato, E., Lagunoff, R., & Worth, P. (2011). *SMARTER Balanced Assessment Consortium Common Core State Standards analysis: Eligible content for the summative assessment* (Final Report). Retrieved from [eric.gov?id=ED536959](http://eric.gov?id=ED536959)
- Schwartz, D., & Bransford, J. (1998). A time for telling. *Cognition and Instruction*, 16, 475–522.
- Sforza, D. (2014). *The inclusion of cognitive complexity: A content analysis of New Jersey's current and past intended curriculum* (Doctoral dissertation). Retrieved from <http://scholarship.shu.edu/dissertations/2020>
- Sforza, D., Tienken C. H., & Kim, E. (2016). A comparison of higher order thinking between the Common Core State Standards and the 2009 New Jersey Content Standards in high school. *AASA Journal of Scholarship & Practice*, 12(4), 4–29.
- Shukla, D., & Dungsungnoen, A.P. (2016). Student's perceived level and teachers' teaching strategies of higher order thinking skills: A study on higher educational institutions in Thailand. *Journal of Education and Practice*, 7(12), 211–219.
- Silva, E. (2009). Measuring skills for 21st-century learning. *The Phi Delta Kappan*, 90(9), 630. Retrieved from [http://iwebpx.saschina.org/theronmott/frc/Articles\\_files/Measuring\\_Skills\\_for\\_21st\\_Century.pdf](http://iwebpx.saschina.org/theronmott/frc/Articles_files/Measuring_Skills_for_21st_Century.pdf)
- Sloan, J. (2006). *Learning to think strategically*. Oxford, UK: Butterworth-Heinemann.
- Snow, K. (2015). A framework for considering the validity of learning standards. *National Association for the Education of Young Children*, 10, 1–18. Retrieved from [https://www.naeyc.org/files/naeyc/Common\\_Core\\_Brief\\_2015\\_content.pdf](https://www.naeyc.org/files/naeyc/Common_Core_Brief_2015_content.pdf)
- Soulé, H., & Warrick, T. (2015). Defining 21st century readiness for all students: What we know and how to get there. *Psychology of Aesthetics, Creativity, and the Arts*, 9(2), 178–186. doi:10.1037/aca0000017

- Sousa, D. (2001). *How the brain learns* (4th ed.). Thousand Oaks, CA: Corwin.
- Standard Chartered Global Focus. (2010, April). *The winning ingredients: Shaping the new world order*. Retrieved from [https://members.bccthai.com/asp/view\\_doc.asp?DocCID=1637](https://members.bccthai.com/asp/view_doc.asp?DocCID=1637)
- Sternberg, R. J. (1996). *Successful intelligence: How practical and creative intelligence determine success in life*. New York, NY: Simon & Schuster.
- Sternberg, R. J. (2006). The nature of creativity. *Creativity Research Journal*, 18(1), 87–98. doi:10.1207/s15326934crj1801\_10
- Sulla, N. (2011). *Students take charge: Inside the learner-active technology infused classroom*. New York, NY: Routledge.
- Sulzer, M. (2014, May). The Common Core State Standards and the ‘basilisation’ of youth. *English Teaching: Practice and Critique*, 12(1), 134–154.
- Tan, O. S. (2015). Flourishing creativity: Education in an age of wonder. *Asia Pacific Education Review*, 16(2), 161–166.
- Tienken, C. H. (2011). Common Core State Standards: An example of data-less decision making. *AASA Journal of Scholarship and Practice*, 7(3), 3–5.
- Tienken, C. H. (2012). What education policy could be. *Kappa Delta Pi Record*, 75, 298–314.
- Tienken, C. H. (2013). Dissect, design, and customize the curriculum. *Kappa Delta Pi Record*, 49, 9–11.
- Tienken, C. H. (2015, January 24). *Parking the rhetoric on PARCC* [Web log post]. Retrieved from <http://christienken.com/2015/01/24/parking-the-rhetoric-on-parcc/>
- Tienken, C. H. (2016). *Defying standardization: Creating curriculum for an uncertain future*. Lanham, MD: Rowman and Littlefield.
- Tienken, C. H., & Canton, D. (2009). National curriculum standards: Let’s think it over. *AASA Journal of Scholarship and Practice*, 6(3), 3–9.
- Tienken, C. H., & Orlich, D.C. (2013). *The school reform landscape: Fraud, myth and lies*. Lanham, MD: Rowman & Littlefield Education.
- Tienken, C. H., & Zhao, Y. (2010). Common core national curriculum standards: More questions...and answers. *AASA Journal of Scholarship and Practice*, 6(4), 3–11.



- Toscano, M. (2013). The Common Core: Far from home. *Academic Questions*, 26(4), 411–428. doi:10.1007/s12129-013-9389-9
- Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Francisco, CA: John Wiley & Sons.
- Turner-Bisset, R. (2007). Performativity by stealth: A critique of recent initiatives on creativity. *Education 3-13*, 35, 193–203.
- U.S. Department of Commerce. (2012). *The competitiveness and innovation capacity of the United States*. Retrieved from [http://www.commerce.gov/sites/default/files/documents/2012/january/competes\\_010511\\_0.pdf](http://www.commerce.gov/sites/default/files/documents/2012/january/competes_010511_0.pdf)
- U.S. Department of Education. (2017). Every Student Succeeds Act (ESSA). Retrieved from <https://www.ed.gov/essa?src=rn>
- VanTassel-Baska, J. (2015). Arguments for and against the Common Core State Standards. *Gifted Child Today*, 38(1), 60–62.
- Wang, M. C., Haertel, G. D., & Walberg, H. J. (1993). Toward a knowledge base for school learning. *Review of Educational Research*, 63(3), 249–294.
- Webb, N. L. (1997). *Criteria for alignment of expectations and assessments in mathematics and science education* (Research Monograph No. 6). Washington, DC: Council of Chief State School Officers.
- Webb, N. L. (1999). *Alignment of science and mathematics standards and assessments in four states*. Washington, DC: Council of Chief State Officers and National Institute for Science Education.
- Webb, N. L. (2007). Issues related to judging the alignment of curriculum standards and assessments. *Applied Measurement in Education*, 20, 7–25.
- Webb, N. L., Alt, M., Ely, R., & Verperman, B. (2005). *Web alignment tool training manual*. Wisconsin Center for Educational Research. Retrieved from <http://wat.wceruw.org/index.aspx>
- Wheeler, P., & Haertal, G. (1993). *Resource handbook on performance assessment and measurement*. Berkley, CA: The Owl Press.
- Wilson, L. O. (2001). *Anderson and Krathwohl – Bloom's taxonomy revised*. Retrieved from <http://thesecondprinciple.com/teaching-essentials/beyond-bloom-cognitive-taxonomy-revised/>
- Wirkala, C., & Kuhn, D. (2011). Problem-based learning in K–12 education: Is it effective and how does it achieve its effects? *American Educational Research Journal*, 48(5), 1157–1186.

- World Economic Forum. (2015). *New vision for education: Unlocking the potential for technology*. Retrieved from [http://www3.weforum.org/docs/WEFUSA\\_NewVisionforEducation\\_Report2015.pdf](http://www3.weforum.org/docs/WEFUSA_NewVisionforEducation_Report2015.pdf)
- Wyse, A. E., & Viger, S. G. (2011). How item writers understand depth of knowledge. *Educational Assessment, 16*(4), 185–206.
- Yin, R. K. (2008). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage.
- Young, L. E. (1992). Critical thinking skills: Definitions, implications for implementation. *NASSP Bulletin, 76*, 47–53. doi:10.1177/019263659207654806
- Yuan, K., & Le, V. N. (2012). *Estimating the percentage of students who were tested on cognitively demanding items through the state achievement tests*. Santa Monica, CA: Rand Corporation.
- Zhao, Z. (2012). *World class learners*. Thousand Oaks, CA: Corwin.