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# Cognitive Language and Content Standards: Language Inventory of the Common Core State Standards in Mathematics and the Next Generation Science Standards

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**Abstract**

STEM education is a current focus of many educators and policymakers and the Next Generation Science Standards (NGSS) with the Common Core State Standards in Mathematics (CCSSM) are foundational documents driving curricular and instructional decision making for teachers and students in K-8 classrooms across the United States. Thus, practitioners and researchers need to possess a deep and working understanding of these standards. This study aims to examine how terms within the CCSSM and the NGSS are used and aligned by addressing the following research questions: (1) What common terminology is found across CCSSM and NGSS? (2) How does the terminology between the CCSSM and the NGSS compare to one another? (3) How do the cognitive terms found in CCSSM and NGSS change across grade bands? The findings indicate that there are numerous places where common terminology is aligned and used similarly both across grade bands and between the sets of standards. Conversely, many other terms are used with varying degrees of emphasis. Because STEM is presented as a holistic subject, these variable meanings and/or expectations reveal the potential for misguided expectations within the classroom as students, teachers, and principals use the same terminology in multiple, but distinct contexts.

## Introduction

In the advent of federal education policies like No Child Left Behind (2002) and Race to the Top (U.S. Department of Education, 2009), most states and/or school districts have adopted content standards; namely the Common Core State Standards (CCSS) and Next Generation Science Standards. Presently, 43 states and the District of Columbia have adopted the CCSS (Achieve, 2015) and 18 of these same states along with the District of Columbia have adopted the NGSS (Academic Benchmarks, 2015), while several other states have pending adoption decisions. In addition to the 18 states that have formally adopted the NGSS, numerous school districts have implemented the NGSS independent of their state policies (Heitin, 2015).

Thousands of educators and students in K-8 classrooms around the country are dependent on these documents. Thus, it is important for practitioners and researchers to possess a deep and working understanding of the standards as they serve as the educational expectations for instruction and learning. One way to help in this process is to examine and analyze the documents themselves. The language use and cognitive demands conveyed both between the standards and across the grade level progressions are a natural place to begin to develop this deep understanding. Accordingly, primary goal of our research is to begin to establish a coherent understanding of the interconnectedness of the terminology within and across the K-8 standards.

The CCSS and NGSS were not the first documents of their kind but are the most recent content standards and built on those that came previously. For example, the National Research Council (NRC) used the National Science Standards from 1996, with research on the cognitive processes involved in how people learn and the research in this area, along with collaborative work with numerous stakeholders to create of a set of learning standards known as the NGSS. The purpose of both sets of standards is to offer a more valuable and complete approach to learning within these disciplines for all students (Achieve, 2013; The National Academic Press National Governors Association Center for Best Practices, & Council of Chief State School Officers, 2010) by developing the “cognitive skills, such as problem solving, collaboration, and academic risk taking” (Phillips & Wong, 2010) within the arena of mathematic and scientific literacy. In addition, Achieve, Inc., the organizing body that released the NGSS materials, write that these two sets of standards are aligned "to ensure a symbiotic pace of learning in all content areas… [and] offer an opportunity to give all students equitable access to learning standards" (Achieve, 2013).

Previous research tells us that teachers are heavily dependent on curricular and instructional materials (Brown, 2011), and the use of these curricular materials depends profoundly on teachers' interpretation and orientation of them (Remillard & Bryans, 2004). Interpretation, understanding, and orientation hinges at least partially on the communicative message(s) (or the wording) to the stakeholders (Lunenberg & Ornstein, 2012) regarding the standards' intended meaning. To date, no research has closely examined the specific terminology used across the CCSS and NGSS that communicate to educators what their leaners are supposed to do. This study aims to examine how the terms within the CCSS for mathematics (herein written as CCSSM) and the NGSS are used and aligned, and also aims to reveal the emergent patterns stemming from word use selection. This research also begins to answer questions related to transfer of learning as we present here a portion of the findings from a larger study focused on the transfer of student learning and cognition between science and mathematics at the elementary and middle school levels as evidenced by assessment data. Because there is burgeoning interest in transfer (Kiray, 2012; Mayer, Sodian, Koerber, & Schwippert, 2014; Royer, Mestre, & Dufresne, 2005), work such as this could help to explain the transfer of learning across disciplinary and grade contexts since elementary students are typically in the same classroom taught by the same teacher. This study is worthwhile as it holds potential to impact educators' understanding of the documents and therefore, may impact the implementation of the content standards at the classroom level.

Not only does the states' adoptions of the CCSSM and NGSS offer a timely context for this study, STEM education, which is the overarching categorization involving the disciplines of science, technology, engineering, and mathematics, is a current focus of many educators and policymakers. The attention to the STEM fields continues to increase since its emergence in the late 1980s (Assefa & Rorissa, 2013; Breiner, Harkness, Johnson, & Koehler, 2012) and STEM is actively promoted in the education policy arena where recent endorsements are found within the competitive Race to the Top education grant of 2009 (Johnson, 2013) and the dedication of billions of dollars by the U.S. federal government to this field (Breiner et al., 2013).

## Review of the Literature

### STEM Education

Despite its public promotion by policy makers, educators, and researchers alike, literature surrounding the STEM movement reveals that STEM education programs present an interesting and challenging endeavor for implementation in schools for two primary reasons. First, this field is extremely broad. For example, the singular domain of science has numerous sub-sections like biology, physics, chemistry, earth science, etc. Secondly, to many professionals who work in this arena, the title of "STEM" implies a coordinated curricular integration. The goal of blending the STEM disciplines together systematically and strategically helps drive its progression in educational programming (Breiner et al. 2012; Chiu, Price, & Ovrahim, 2015; Johnson, 2013). The concurrent adoptions of CCSSM and NGSS offer a platform for this integrated approach (Johnson, 2013) and the examination of these documents can help to highlight places of natural connections or places where the uniqueness of the disciplinary fields need to be recognized.

With the current efforts to converge the separate STEM disciplines into one area (Breiner et al., 2012), we argue that there is a potential for misinterpretation and miscommunication if inconsistent use of terms and/or definitions across the two sets of distinct standards exists. In other words, the "separate disciplines" within STEM although related, are distinctly separate; with unique, field-specific practices and expectations. Thus the amalgamation of the STEM fields under a singular umbrella poses a threat of failing to honor each discipline's distinctness.

Assefa and Rorissa (2013) suggest that "[u]nderstanding the complex web of relationships surrounding the field of STEM education is the first step to better planning of curricular activities, programs, and research" (p. 2514). Chiu et al. (2015), in their literature review of the support for STEM in younger grades, reported that little research in general exists on elementary and middle school STEM education and pedagogy. In the present study, we begin to uncover if the word selection within the standards themselves poses a challenge to an integrated STEM approach in this standards-based accountability era of education policy and curriculum.

### Connections and Cognitive Transfer between Mathematics and Science

This study focuses on the mathematics and science components of STEM. Mathematics and science have a long history of being linked in K-12 settings. Therefore, it is unsurprising that research exists which examines the connection between mathematics and science learning, offering implications for classroom instruction.

Integration of disciplines and the communication surrounding how to achieve integration may impact the epistemological transfer of knowledge and skills from one context to another (Hoban, Finlayson, & Nolan, 2013). Several empirical studies have examined this phenomenon across mathematics and science classrooms and the extant research describes the process of students transferring their skills. Unlike the present study, much of the evidence found is primarily situated in the high school or undergraduate mathematics and science contexts (e.g. Brogt, Soutter, Masters, & Lawson, 2014; Bassok & Holyoak, 1989; Hoban et al., 2013; Marrongelle, 2004; Potgieter, Harding, & Engelbrecht, 2008). Frykholm and Glasson (2005) recognize the natural connections, relationships, and overlap between these two areas in the classroom and from their work, they determined that necessary training is needed for teachers to make strategic and deliberate integration of these two subjects. It follows then, as more and more schools make strides to implement the CCSSM and NGSS, a cogent integrative approach may be applied if a deep understanding of the standards' expectations is realized.

### Cognition and Epistemology

The bridge between mathematics and science is strengthened by the research that exists on cognition and how cognitive processes are shared between these two disciplines. Students draw upon different "cognitive resources" when engaged in epistemological practices (Hammer, Elby, Scherr, & Redish, 2005). Because existing research offers evidence of connections between cognitive processes in mathematics and science, we can draw on the work of Glaser (1984) who argues that these cognitive connections should be "explicitly developed in the process of acquiring the knowledge and skills that we consider the objectives of education and training" (p. 93). Through an understanding of the cognitive processes with which students engage in the classroom, it is recognized that "students' everyday thinking [involves] myriad cognitive resources, and we frame our questions in terms of when and how students activate those resources" (Hammer et al., 2005, p. 90) to provide evidence of learning. In these settings, language becomes the vehicle through which educators can guide their students and students can demonstrate their progress.

Domain-specific knowledge impacts cognitive thinking, and as knowledge structures widen into organized knowledge schema, these then influence learning across disciplines (Glaser, 1984; Lawson, 1985). For example, the disciplines of mathematics and science offer rich opportunities for problem solving and activation of knowledge constructs between domains. The standards articulate what students should be learning as they advance through school and also align with the implications from the existing research that stresses the need for classroom instruction to be grounded appropriately as students move from grade to grade. Theoretically, as students progress through school, their cognitive processes, skills, and resources will also progress. The recognition of age-appropriate subject-specific expectations could provide a rich opportunity for educators to collaborate across grade levels and subject areas in order to find places in the content standards where connections can be harnessed and developed more deeply for students.

Be it formal knowledge development in schools or in informal learning settings, "epistemological resources tend to become activated in locally coherent sets" (Hammer et al., 2005, p. 98). We then surmise that over time knowledge and skills become more nimble with increased utility within the cognitive practices and these epistemological practices are iterative, eventually becoming routine, ontological cognitive processes of knowledge transfer (Hammer et al, 2005).

### Language

The expectations of the standards are articulated through the written language in the documents: standards, their supplementary materials, research materials, and resources used by individuals and groups aiding implementation. Dedicating the necessary attention to language is critical in the current standards and accountability era as coherence in communication provides clarity of both meaning and expectations for primary stakeholders (Lunenberg & Ornstein, 2012). The language in specific contexts impacts both the ways in which teachers will interpret the standards and the ways in which students can apply their learning from one subject to another (diSessa & Wagner, 2005; Hammer et al., 2005).

In this study, the word "language" is defined as the terms, vocabulary, or word choices directly found in the CCSSM and NGSS documents. This is especially relevant in the micro-educational setting of a classroom and the macro-educational setting of a state or federal policy. What is expected of students rests primarily on how the teacher in the everyday micro-educational setting makes instructional decisions (Cobb, Boufi, McClain, & Whitenack, 1997; Dufresne, Mestre, Thaden-Koch, Gerace, & Leonard, 2005) and with the policymakers and standards and assessment developers (Hickey & Pellegrino, 2005) within the larger, macro-educational environment.

Extant literature within mathematics and science education research emphasizes the importance of language. In science, it is recognized that "language plays a central role in scientific practice (and therefore scientific literacy) because it requires and develops abilities such as metacognition and critical reasoning" (Cavagnetto, 2010). In mathematics, language choice fills a prominent factor for development in this discipline (Truxaw & DeGranco, 2008). Language development is advanced through the word choices selected for dialogue in mathematics and science classes, and dialogue "is a useful construct in that it suggests possible relationships between classroom discourse and mathematical development" (Cobb et al., 1997, p. 274-275). Our project will offer a continuation of this line of research that uniquely examines the importance of language across the different disciplinary documents.

## Cognitive Domain Language in STEM

The two well-known international studies in STEM include the Programme for International Student Assessment (PISA) which "measures 15-year-old students' reading, mathematics, and science literacy every three years" (U.S. Department of Education, n.d.a) and the Trends in International Mathematics and Science Study (TIMSS) which "provides reliable and timely data on the mathematics and science achievement of U.S. students compared to that of students in other countries. TIMSS data have been collected from students at grade 4 and 8 since 1995 every 4 years" (U.S. Department of Education, n.d.b). Unlike PISA, TIMSS tests elementary and middle school students, and focuses solely on mathematics and science.

Different epistemological resources are connected to the TIMSS cognitive domain categories. The TIMSS International Study Center embarked on a project in 2002 to classify the assessment components into the three distinct cognitive domains: *Knowing, Applying,* and *Reasoning* (Thomson, 2006). The first:

> covers what the student needs to know, while the second, *applying knowledge and conceptual understanding*, focuses on the ability of the student to apply what he or she knows to solve routine problems or answer questions. The third domain, *reasoning*, goes beyond the solution of routine problems and simple recall of facts to encompass unfamiliar situations, complex contexts, and multi-step problems (p. 2).

The cognitive domains, used in this well-known international assessment are utilized as an organizing framework for our study. More details outlining its use are described later in the methods section of this paper.

## Inventory Studies

Previous inventory or inventory-like studies exist which examine terms or take record of educational elements like textbooks or curricula. Within the body of work on taking inventory, Assefa and Rorissa (2013) analyzed articles in STEM education using a bibliometric mapping approach and found that engineering data is not readily found in elementary contexts, but other, predictable terminology was frequently found along with subjects such as policy, curriculum, and professional development. Their research findings reveal a potential challenge that educators will face as the NGSS includes a strong engineering component.

Other studies examine the terminology within textbooks (Abualrob & Daniel, 2013) or how science programs match the intended curriculum (Kesidou & Roseman, 2002). No inventory studies exist at this time that comparatively examines the terminology across the latest content standards. This study aims to fill this gap adding to the current body of literature in this field by reporting the inventory of terminology found in the CCSSM and NGSS.

**Research Questions**

The purpose of this study is to examine and highlight the commonalities and differences in word use emphasis across the CCSSM and the NGSS. The answers to our research questions may be especially relevant for stakeholders in states and school districts that adopt these standards especially as STEM education is promoted nationwide. The three research questions that drive this portion of the study are:

(1) What common terminology is found across CCSSM, and NGSS?
(2) How does the terminology between the CCSSM and the NGSS compare to one another?
(3) How do the cognitive terms found in CCSSM and NGSS change across grade bands?

## Methods

Several steps across two phases took place in order to address the three research questions. During both phases, a research team of two professors and three graduate students collaborated regularly to monitor progress on this project, make decisions about various components of the research, and discuss the data as they were collected. The first phase included decisions around the organization of the study's procedures, the terms of which to take inventory, how to categorize the terms, and determine the total counts of each term within each set of standards (CCSSM and NGSS). During the second phase, additional data were gathered and organized. During this second phase, ratios of term use were determined and the frequencies of individual words were also recorded and analyzed by grade band. The frequencies of words were compared between and within standards. Each step is discussed in greater detail below.

Table 1: Term Inventory across CCSSM and NGSS

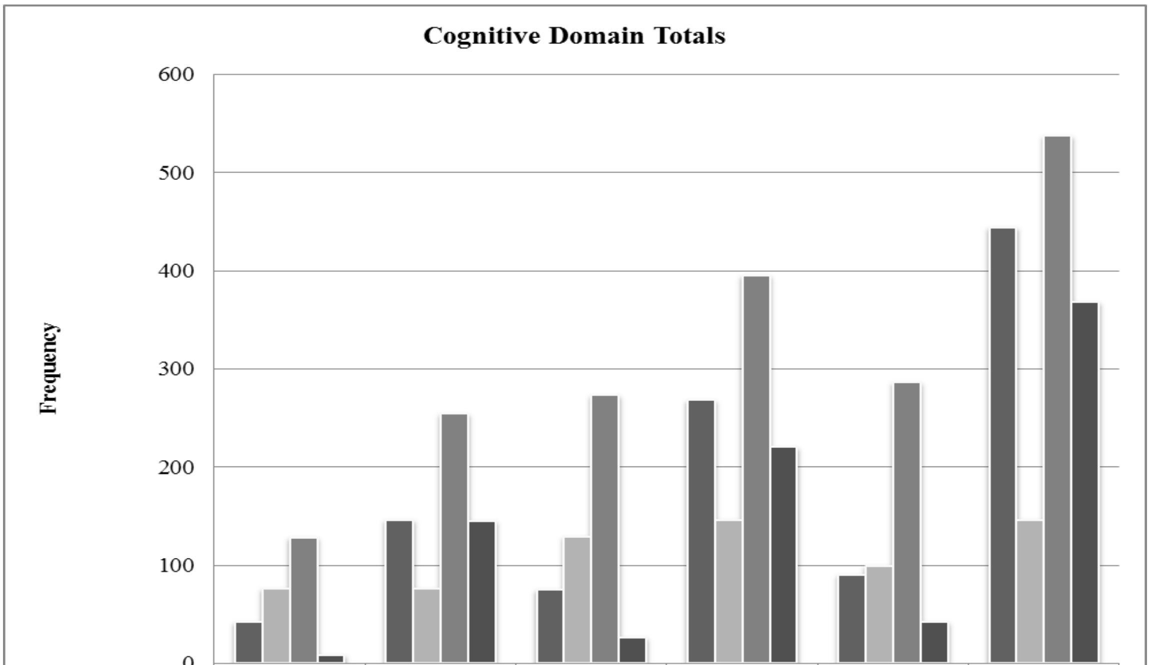
| Practice | | Knowing | | Applying | | Reasoning | |
|---|---|---|---|---|---|---|---|
| Word | Count | Word | Count | Word | Count | Word | Count |
| Argue | 101 | Compute | 33 | Classify | 21 | Analyze | 174 |
| Claim | 35 | Define | 62 | Compare/ Contrast | 125 | Design | 295 |
| Conjecture | 0 | Demonstrate knowledge of scientific instruments | 6 | Explain | 273 | Draw Conclusions | 35 |
| Data | 252 | Describe | 242 | Find Solution | 348 | Evaluate | 68 |
| Defend | 0 | Illustrate | 5 | Implement | 2 | Generalize/ Specialize | 31 |
| Evidence | 262 | Measure | 200 | Interpret Information | 116 | Hypothesize/ Predict | 58 |
| Interpret | 116 | Order | 40 | Model/Model Use | 340 | Integrate/ Synthesize | 142 |
| Reason | 147 | Recall | 20 | Relate | 257 | Justify | 6 |
| Support | 137 | Recognize | 64 | Represent | 184 | | |
| Valid | 15 | Retrieve | 0 | Select | 12 | | |
| | | | | Solve | 195 | | |
| TOTAL | 1,065 | TOTAL | 672 | TOTAL | 1,873 | TOTAL | 809 |

**Phase 1**

Over the course of several meetings, the research team involved with this larger study met to review and generate a list of terms selected for frequency analysis. The researchers began with brainstorming words associated with high-level cognitive demands. Following, the TIMSS cognitive domain categories and individual terms were considered for inclusion. Thirty-one terms originally associated with the TIMSS cognitive demands are categorized within the aforementioned themes of (1) *Applying,* (2) *Reasoning,* and (3) *Knowing.* Additional words offered at team meetings, that were not already included in the established TIMSS categories, were placed in an fourth theme of epistemological *Practice*; and reasons for inclusion were based on existing literature and previous professional experience; and again, agreed upon by the members of the research team. The four themes (*Applying, Reasoning, Knowing,* and *Practice*) were then used as an organizing framework for the study. This taxonomy contained 43 total terms in the four themes. See Table 1 for a composite list of these terms.

One member of the research team utilized electronic versions of the CCSSM (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), and the NGSS (NGSS Lead States, 2013) to take an inventory of the word counts. For each of the 43 terms, specific root word/terms were used as search items (e.g. "classif" was used for Classify to capture terms like classify, classified, classification). Once the initial counts were determined from each of the searches, efforts were made to only include terms that pertained to that requiring student action. For example, the term "support" is used in the context of a sentence like, "teachers provide support to students." These types of occurrences were removed and not included in the word frequency inventory. These data were then organized and arranged in Microsoft Excel to help with the analysis, discussion, and interpretation of term frequencies.

The word frequencies within each of the four themes were summed and they are reported in a table (See Table 1) and categorically depicted in a figure (see Figure 1). This table contains the total number of for each individual term across each of the three sets of standards and placed under its cognitive domain heading. Arranging the inventory this way gave the research team an indication of what types of cognitive demands are communicated as expectations, places of emphasis, and conveyed as valuable within these documents.




| | K-2 CCSSM | K-2 NGSS | 3-5 CCSSM | 3-5 NGSS | 6-8 CCSSM | 6-8 NGSS |
|---|---|---|---|---|---|---|
| PRACTICE | 42 | 146 | 75 | 268 | 90 | 444 |
| KNOWING | 76 | 76 | 129 | 146 | 99 | 146 |
| APPLYING | 128 | 254 | 273 | 395 | 286 | 537 |
| REASONING | 8 | 145 | 26 | 220 | 42 | 368 |

Figure 1: Word Frequencies by Cognitive Domain

### Phase 2

The next steps marked a second phase of the study: a phase that specifically answers the second and third research questions listed above. During this phase, some of the terms were adjusted from the original term from the TIMSS documents. For example, the term Draw Conclusions was expanded to include word counts of Draw Inferences and Draw Evidence. Where adjustments to the TIMSS's terms were made, it was done with the consensus of the research team under the premise of working to more completely understand the intent of the standards' expectations for student learning.

Word counts within grades were calculated and recorded during this step. The decision to break the inventory down by grade bands instead of individual grades stems from the NGSS documents. The NGSS is broadly organized in three grade bands: K-2, 3-5, 6-8. Following this arrangement, we decided to organize the data similarly. Counts were organized by cognitive domain/term/grade band in excel. Then, during a research team meeting, it was suggested that proportions of each term be calculated that compared the frequency number to the total word count (of the cognitive terms) of the specific set of standards (i.e. Synthesize count / total cognitive words in NGSS grade band K-2). The inventory of raw word counts and the count proportions were organized in Microsoft Excel tables and bar graphs. From these tables and graphs, the research team analyzed their use.

## Findings

### Cognitive Domain Word Frequencies across Standards

The evidence pertaining to the first research question displays a broad, overriding picture of the types of skills and language emphasized by the creators of the CCSSM and NGSS. From the term inventory (see Table 1 above), it is noted that the cognitive categories of *Applying* and *Practice* contain the highest counts of terms. There are 1,873 *Applying* words recorded and 1,065 *Practice* terms. *Knowing* and *Reasoning* have notably lower counts at 672 and 809 respectively.

From these data, it appears that the writers of the standards expect students to do more and use the content in order to produce or take action with their knowledge, rather than merely repeat, parrot, or report on their learning. For example, the frequency of terms like Model (340 times), Explain (273 times), and Evidence (262 times) show that content knowledge alone is not a sufficient level of understanding. Rather, expanding upon developing knowledge and using it appropriately are the goals in learning according to what is prevalent and emphasized in the CCSSM and NGSS.

### Comparison across Standards and Grade Bands

Answering the second and third research questions required a more focused and targeted simultaneous look at the data across the standards and within the four cognitive domains. These data are displayed in the bar graphs in Figures 1-9. The CCSSM document contains nearly 1,300 of the key cognitive domain words across all grade bands (K-2 = 254; 3-5 = 503; 6-8 = 517). The NGSS document across all grade bands contains over 3,000 of these terms (K-2 = 621; 3-5 = 1,029; 6-8 = 1,495). This portion of the study provided an inventory and analyses of the 4,419 total words in mathematics and science using the TIMSS + *Practice* cognitive domains as the primary organizing framework. The raw counts and the proportions of each term are provided. Proportions were calculated by taking the raw count and dividing it by the total number of cognitive words per grade band in each standard set. The results from the TIMSS domains: *Applying*, *Reasoning*, and *Knowing* and the *Practice* categories are described below.

The inventory of words across the CCSSM and NGSS indicates that there are similar uses of language across the standards but differences are also apparent and are in need of attention. The discrepancies may stem from discipline- or field-specific expectations for performance and learning. Or the differences may stem from unique terminology in either discipline. For instance, in the NGSS, students are asked to use a model or create a model to demonstrate learning. A fourth grade physical science (PS) standard invites students to "Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move" (4-PS4-1). In the CCSSM, students are asked to use or model their understandings through solving routine or non-routine math problems. A fourth grade mathematics standard instructs students to "Explain why a fraction $a/b$ is equivalent to a fraction $(n \times a)/(n \times b)$ by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions" (Number and Operations – Fractions 4.NF.1). Differences in expectations while using the same word to communicate meaning may pose a challenge to effective instruction, learning, and knowledge use as well as the potential for transfer.

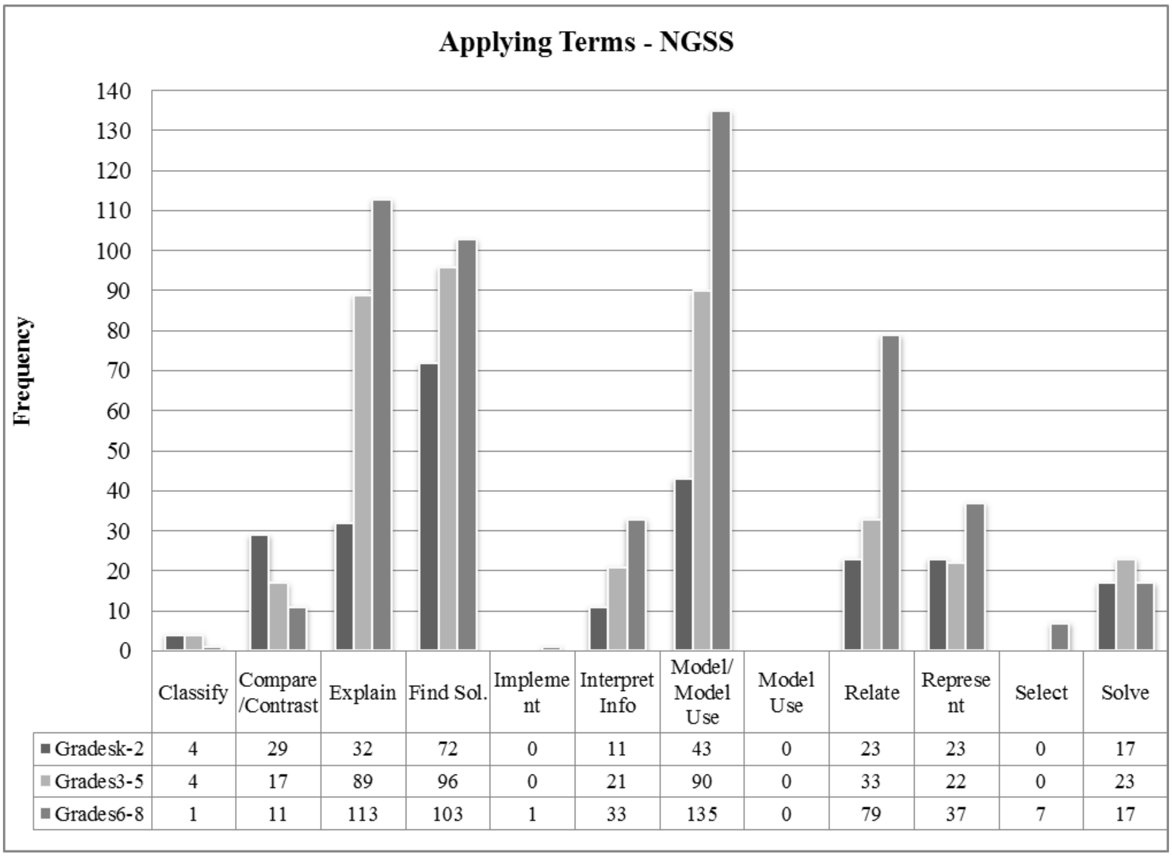
The following portion will highlight the differences between the word choices in the CCSSM and NGSS by the four domain categories and the changes in word emphasis between and across grade bands. Due to space limitations, the findings will feature those places where there is evidence of inconsistent word counts, or notable patterns that emerged. We chose to focus our attention on those places of divergence, as they are the potential loci for misinterpretation, miscommunication, or misalignments by policy makers, assessment developers, educators, and students. The information summarizes the findings and adds specificity to the evidence provided above in order to more thoroughly address the second and third research questions. The numeric reporting provides the raw count with the proportion included in parenthesis next to the raw count number.

### *TIMSS Domain: Applying*

The numeric and proportional summaries of all the terms in this domain can be found in Table 2. An aggregated bar graph for the terms in this domain can be found in Figures 2 and 3. Three of the twelve *Applying* terms are consistently used in the standards across grade bands and are similarly emphasized in both the CCSSM and NGSS. These terms include: Classify, Select, and Implement.

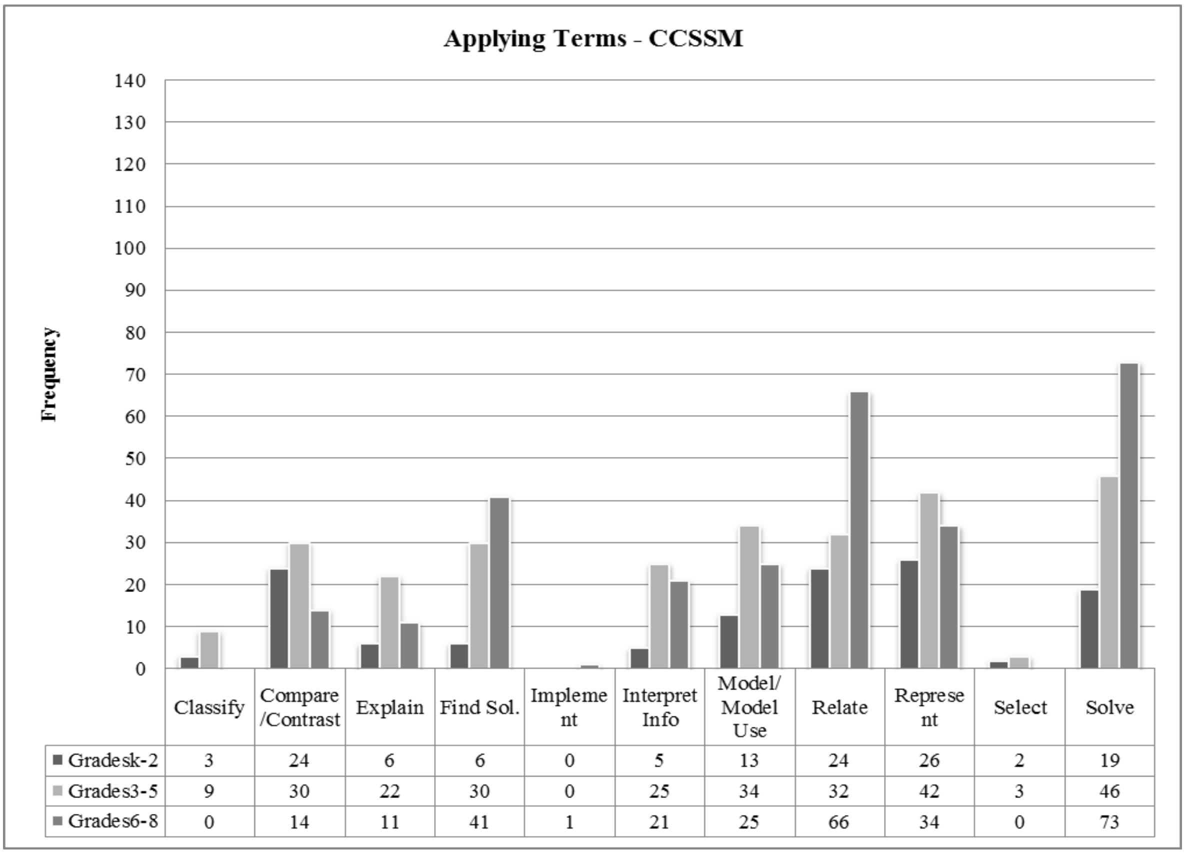
Table 2*: Applying Word Inventory-Raw (Proportion)*

| | Grade | | |
|---|---|---|---|
| Word | K-2 | 3-5 | 6-8 |
| **Classify** | | | |
| NGSS | 4 (0.006) | 4 (0.004) | 1 (0.001) |
| CCSSM | 3 (0.162) | 9 (0.018) | 0 (0) |
| **Compare/Contrast** | | | |
| NGSS | 29 (0.047) | 17 (0.017) | 11 (0.014) |
| CCSSM | 24 (0.094) | 30 (0.060) | 14 (0.044) |
| **Explain** | | | |
| NGSS | 32 (0.052) | 89 (0.087) | 113 (0.090) |
| CCSSM | 6 (0.024) | 22 (0.044) | 11 (0.065) |
| **Find Solution** | | | |
| NGSS | 72 (0.116) | 96 (0.093) | 103 (0.159) |
| CCSSM | 6 (0.024) | 30 (0.103) | 41 (0.079) |
| **Interpret Information** | | | |
| NGSS | 11 (0.017) | 21 (0.020) | 33 (0.022) |
| CCSSM | 5 (0.020) | 25 (0.050) | 21 (0.014) |
| **Model/Model Use** | | | |
| NGSS | 43 (0.069) | 90 (0.087) | 135 (0.271) |
| CCSSM | 13 (0.051) | 34 (0.068) | 25 (0.048) |
| **Relate** | | | |
| NGSS | 23 (0.106) | 33 (0.120) | 79 (0.053) |
| CCSSM | 24 (0.095) | 32 (0.064) | 66 (0.128) |
| **Represent** | | | |
| NGSS | 23 (0.106) | 22 (0.021) | 37 (0.025) |
| CCSSM | 26 (0.102) | 42 (0.083) | 34 (0.193) |
| **Select** | | | |
| NGSS | 0 (0) | 0 (0) | 7 (0.005) |
| CCSSM | 2 (0.008) | 3 (0.006) | 0 (0) |
| **Solve** | | | |
| NGSS | 17 (0.027) | 23 (0.022) | 17 (0.016) |
| CCSSM | 19 (0.074) | 46 (0.091) | 73 (0.141) |
| **Implement** | | | |
| NGSS | 0 (0) | 0 (0) | 1 (0.017) |
| CCSSM | 0 (0) | 0 (0) | 0 (0) |




| | Classify | Compare /Contrast | Explain | Find Sol. | Impleme nt | Interpret Info | Model/ Model Use | Model Use | Relate | Represe nt | Select | Solve |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gradesk-2 | 4 | 29 | 32 | 72 | 0 | 11 | 43 | 0 | 23 | 23 | 0 | 17 |
| Grades3-5 | 4 | 17 | 89 | 96 | 0 | 21 | 90 | 0 | 33 | 22 | 0 | 23 |
| Grades6-8 | 1 | 11 | 113 | 103 | 1 | 33 | 135 | 0 | 79 | 37 | 7 | 17 |

Figure 2. Terms in *Applying* Category of NGSS




| | Classify | Compare /Contrast | Explain | Find Sol. | Impleme nt | Interpret Info | Model/ Model Use | Relate | Represe nt | Select | Solve |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gradesk-2 | 3 | 24 | 6 | 6 | 0 | 5 | 13 | 24 | 26 | 2 | 19 |
| Grades3-5 | 9 | 30 | 22 | 30 | 0 | 25 | 34 | 32 | 42 | 3 | 46 |
| Grades6-8 | 0 | 14 | 11 | 41 | 1 | 21 | 25 | 66 | 34 | 0 | 73 |

Figure 3. Terms in *Applying* Category of CCSSM

Several terms (Explain, Interpret Information, Model/Model Use, Solve and Find Solution) generally increase as the grade bands increase. However, the term Compare/Contrast is actually mentioned less often in the 6-8 grade band than in the K-2 grade band both in the NGSS and the CCSSM. The use of the Compare/Contrast does increase in in the CCSSM from 24 mentions (9.4%) in the K-2 band, to 30 times (6%) grades 3-5 band but then drops back down in grades 6-8 with 14 mentions (4.4%).

Similarly, this pattern is also found with the word Explain in the CCSSM where the word counts start at 6 (2.4%), jump to 22 (4.4%), and then drop down to 11 (6.5%). The term is emphasized more often in the NGSS. The K-2 band contains 32 (5.2%) uses of the term, the 3-5 band contains 89 (8.7%) uses, and then in the 6-8 band students are asked to Explain 113 (9%) different times. Surprisingly, Find Solution is mentioned more often in the science standards than in the mathematics standards. In the CCSSM, this term is included 77 different times and 271 times in NGSS.

Students are expected to Interpret Information in both sets of content standards. The expectation for students to Interpret Information increases with the grade levels but is given greater priority in the CCSSM. The three grade bands in NGSS use this term 11 (4.3%) in the K-2 band, 21 (2%) in the 3-5 band, then 33 (2.2%) times in the 6-8 band. The term, in the CCSSM, was counted 5 (2%) times in the K-2 band, 25 (5%) times in the 3-5 band, then 21 (1.4%) times in the 6-8 band.

The terms Model and Model Use were both assigned the same word count. The reason behind this decision is that the definitions and expectations across disciplines seem to mean different things as described earlier and it was not in the scope of this particular paper to analyze and determine each definition of the term and compare its varying use within the two different sets of standards. Therefore, these terms are bundled and presented together. Model/Model Use is emphasized more so in NGSS than in CCSSM. At the K-2 level, the NGSS contains 43 (6.9%) references compared to the CCSSM's count of 13 (5.1%). The 3-5 level also shows a disparity with 90 (8.7%) references in the NGSS and just 34 (6.8%) mentions in the CCSSM. The most advanced 6-8 grade level mentions Model/Model Use 135 (9%) times in the NGSS but only 25 (4.8%) times in the CCSSM.

The word Relate is referenced in CCSSM 24 (9.5%), 32 (6.4%), and 66 (5.5%) times in the K-2, 3-5, and 6-8 grade bands respectively. The NGSS has an initial count of 24 (9.5%) times in the K-2 band, increases to 32 (6.4%) in the 3-5 band, and then rises to 66 (12.8%) references in the 6-8 band. Represent shows some relative consistency between the two standards but they diverge in the middle, 3-5, grade band. Overall, the term Represent is mentioned 20 fewer times in NGSS with 82 mentions than in the CCSSM with 102 times. Lastly, the term Solve has a symmetrical curve of number of uses in NGSS with a progression of 17 (2.7%), 23 (2.2%), 17 (1.6%), but makes a steady rise in frequency in the CCSSM starting at 19 (7.4%) mentions in the K-2 band, increases to 46 (9.1%) mentions in the 3-5 band, then up to 73 (14.1%) times in grade band 6-8.

### *TIMSS Domain: Reasoning*

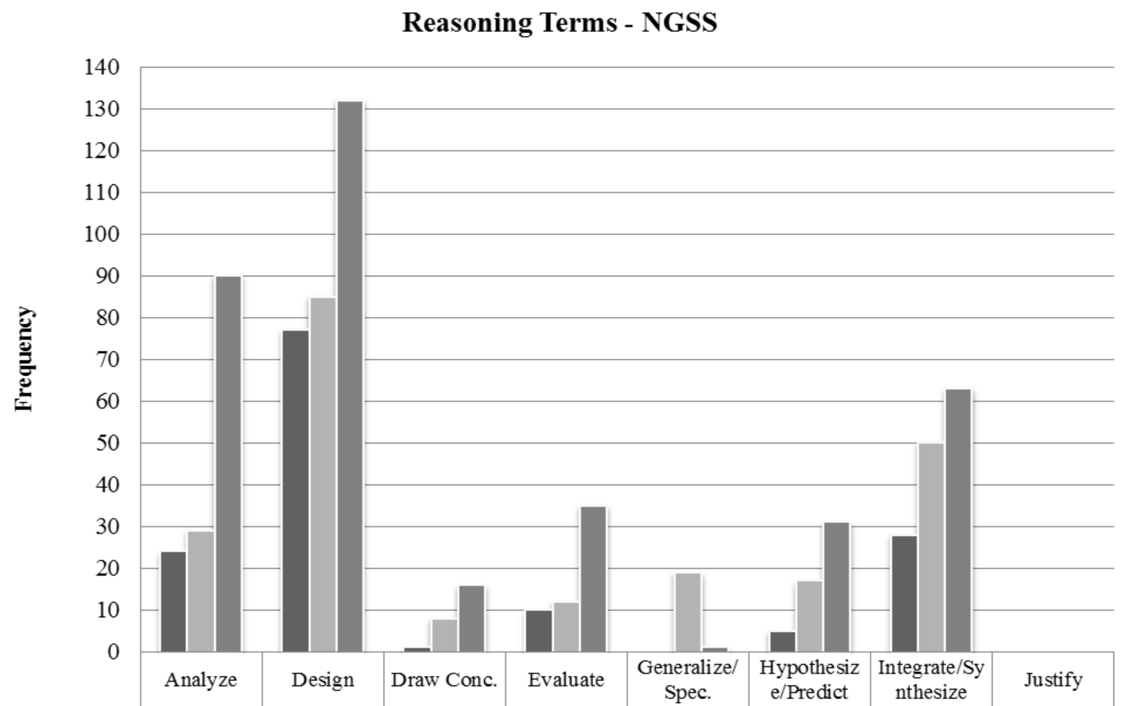
The numeric and proportional summaries of all the terms in the *Reasoning* domain can be found in Table 3. An aggregated bar graph for the terms in this domain can be found in Figures 4 and 5. Of the terms in the *Reasoning* category, the terms Draw Inferences and Draw Conclusions were combined as they provided a more detailed depiction of how students use information in inductive and deductive ways in addition to Draw Conclusions. Two of the ten terms within this domain (Draw Conclusions and Justify) are consistently used in the standards across grade bands and are similarly emphasized in both NGSS and CCSSM.

Analyze is referenced in both NGSS and CCSSM but the emphasis lies more heavily in NGSS. The term is used 24 (3.9%) times in the K-2 band, 29 (2.8%) times in the 3-5 band, then spikes to 90 (6%) uses in the 6-8 grade band. The most prevalent use of Analyze in CCSSM is in the 6-8 grade band with 16 (3.1%) mentions. Analyze is used 6 (2.4%) and 9 (1.8%) times in the K-2 and 3-5 band respectively.

The term Design has an even more dramatic counts use. It is found throughout the NGSS but is almost non-existent in CCSSM (only one mention). Design is a term that is applied to scientific inquiry and also the engineering practices within NGSS. The emphasis on Design in NGSS steadily increases coinciding with the grade band progressions. Design has 77 (12.4%) mentions in the K-2 band, 85 (11.1%) mentions in 3-5 band, and then 132 (14.8%) mentions in the grade band 6-8.

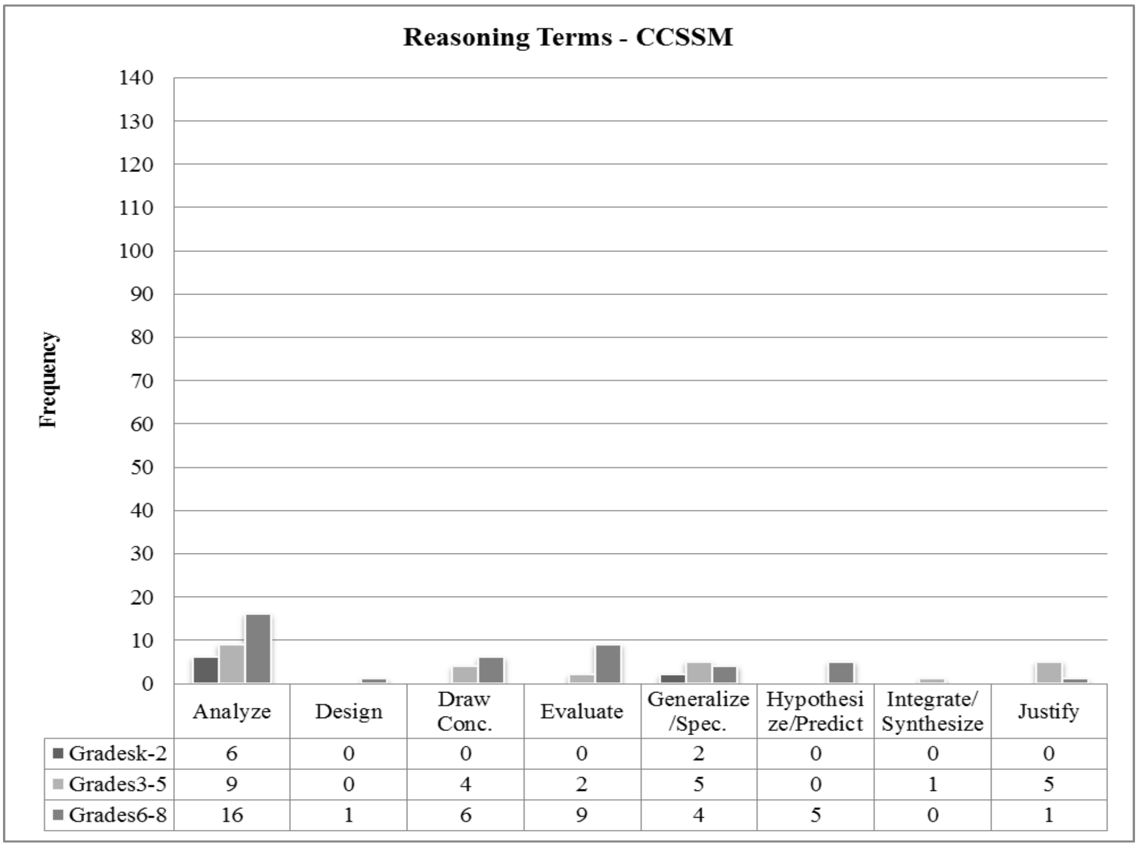
Table 3*: Reasoning Word Inventory- Raw (Prop.)*

| Word | Grade K-2 | 3-5 | 6-8 |
|---|---|---|---|
| **Analyze** | | | |
| NGSS | 24 (0.039) | 29 (0.028) | 90 (0.060) |
| CCSSM | 6 (0.024) | 9 (0.018) | 16 (0.031) |
| **Design** | | | |
| NGSS | 77 (0.164) | 85 (0.111) | 132 (0.001) |
| CCSSM | 0 (0) | 0 (0) | 1 (0.002) |
| **Draw Conclusions/ Draw Inferences** | | | |
| NGSS | 1 (0.002) | 8 (0.008) | 16 (0.023) |
| CCSSM | 0 (0) | 4 (0.008) | 6 (0.014) |
| **Evaluate** | | | |
| NGSS | 10 (0.016) | 12 (0.012) | 35 (0.183) |
| CCSSM | 0 (0) | 2 (0.004) | 9 (0.031) |
| **Generalize/Specialize** | | | |
| NGSS | 0 (0) | 19 (0.030) | 1 (0.001) |
| CCSSM | 2 (0.008) | 5 (0.010) | 4 (0.017) |
| **Hypothesize/Predict** | | | |
| NGSS | 5 (0.008) | 17 (0.017) | 31 (0.021) |
| CCSSM | 0 (0) | 0 (0) | 5 (0.010) |
| **Integrate/Synthesize** | | | |
| NGSS | 28 (0.045) | 50 (0.049) | 63 (0.064) |
| CCSSM | 0 (0) | 1 (0.002) | 0 (0) |
| **Justify** | | | |
| NGSS | 0 (0) | 0 (0) | 0 (0) |
| CCSSM | 0 (0) | 5 (0.010) | 1 (0.002) |




| | Analyze | Design | Draw Conc. | Evaluate | Generalize/ Spec. | Hypothesiz e/Predict | Integrate/Sy nthesize | Justify |
|---|---|---|---|---|---|---|---|---|
| Gradesk-2 | 24 | 77 | 1 | 10 | 0 | 5 | 28 | 0 |
| Grades3-5 | 29 | 85 | 8 | 12 | 19 | 17 | 50 | 0 |
| Grades6-8 | 90 | 132 | 16 | 35 | 1 | 31 | 63 | 0 |

Figure 4. Terms in *Reasoning* Category of NGSS




| | Analyze | Design | Draw Conc. | Evaluate | Generalize /Spec. | Hypothesize/Predict | Integrate/ Synthesize | Justify |
|---|---|---|---|---|---|---|---|---|
| Gradesk-2 | 6 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Grades3-5 | 9 | 0 | 4 | 2 | 5 | 0 | 1 | 5 |
| Grades6-8 | 16 | 1 | 6 | 9 | 4 | 5 | 0 | 1 |

Figure 5. Terms in *Reasoning* Category of CCSSM

Generalize/Specialize shows inconsistent emphasis between the two standards and across the NGSS. The term is used 0 times in K-2, 19 times (3%) in 3-5, and then only 1 time (0.1%) in 6-8. In the CCSS it is used 2 (0.8%), 5 (1%), then 4 (1.7%) times as the grade bands increase. The expectation that students will Draw Inferences, although not heavily underscored in either set of standards, increases differently between them. It is used in NGSS 1 (0.2%) time in the K-2 grade band, 8 (.8%) times in 3-5 band, and 16 (1.1%) times in the 6-8 band. In the CCSSM, the term is not used at all in K-2, 4 times (0.8%) in 3-5 and in grade band 6-8 the term appears 6 (1.4%) separate times.

Evaluate is more consistently found in the NGSS grade bands with counts 10 (1.6%) (K-2), 12 (1.2%) (3-5), and 35 (2.3%) (6-8), but in CCSSM Evaluate increases across the bands at 0 (K-2), 2 (0.03%) (3-5), then 9 (0.11%) (6-8). Next, the Hypothesize/Predict combination term is, perhaps unsurprisingly, only mentioned 5 times in the CCSSM but is used 53 total times across the grade bands in the NGSS. In the same way, there is 141 uses of the combination term Integrate/Synthesize in NGSS, but is only given a one-time mention in CCSSM.

***TIMSS Domain: Knowing***

The numeric and proportional summaries of all the terms in the *Knowing* domain can be found in Table 4. An aggregated bar graph for the terms in this domain can be found in Figures 6 and 7. Four of the ten terms within this domain are consistently used in the standards across grade bands and are similarly emphasized in both NGSS and CCSSM. These terms include: Compute, Demonstrate Knowledge of Scientific Instruments, Illustrate, and Order. The data from the remaining terms' word inventory reveal either inconsistencies or other notable patterns.

Overall, the term Define is used more in NGSS than CCSSM. Students are asked to Define not often, but consistently across grade bands in CCSSM at 3 (0.5%; 2%; .6%) mentions in each. Within the NGSS, the count steadily rises as the grades increase starting with 10 (1.6%) mentions in K-2, 19 (1.8%) in grade band 3-5, and ends with 24 (1.6%) mentions in 6-8.

Table 4: *Knowing Word Inventory-Raw (Proportion)*

| Word | Grade K-2 | 3-5 | 6-8 |
|---|---|---|---|
| **Compute** | | | |
| NGSS | 0 (0) | 8 (0.008) | 8 (0.005) |
| CCSSM | 1 (0.004) | 7 (0.04) | 9 (0.0017) |
| **Define** | | | |
| NGSS | 10 (0.016) | 19 (0.018) | 24 (0.016) |
| CCSSM | 3 (0.005) | 3 (0.020) | 3 (0.006) |
| **Demonstrate Knowledge of Scientific Instruments** | | | |
| NGSS | 1 (0.002) | 1 (0.001) | 4 (0.019) |
| CCSSM | 0 (0) | 0 (0) | 0 (0) |
| **Describe** | | | |
| NGSS | 34 (0.054) | 54 (0.052) | 86 (0.076) |
| CCSSM | 23 (0.091) | 7 (0.014) | 38 (0.080) |
| **Illustrate** | | | |
| NGSS | 1 (0.002) | 1 (0.001) | 0 (0) |
| CCSSM | 0 (0) | 3 (0.006) | 0 (0) |
| **Measure** | | | |
| NGSS | 13 (0.076) | 43 (0.042) | 13 (0.085) |
| CCSSM | 37 (0.146) | 69 (0.134) | 25 (0.128) |
| **Order** | | | |
| NGSS | 7 (0.087) | 4 (0.046) | 5 (0.088) |
| CCSSM | 4 (0.016) | 8 (0.016) | 12 (0.151) |
| **Recall** | | | |
| NGSS | 9 (0.014) | 11 (0.012) | 0 (0) |
| CCSSM | 0 (0) | 0 (0) | 0 (0) |
| **Recognize** | | | |
| NGSS | 1 (0.002) | 5 (0.016) | 6 (0.004) |
| CCSSM | 8 (0.031) | 32 (0.064) | 12 (0.023) |

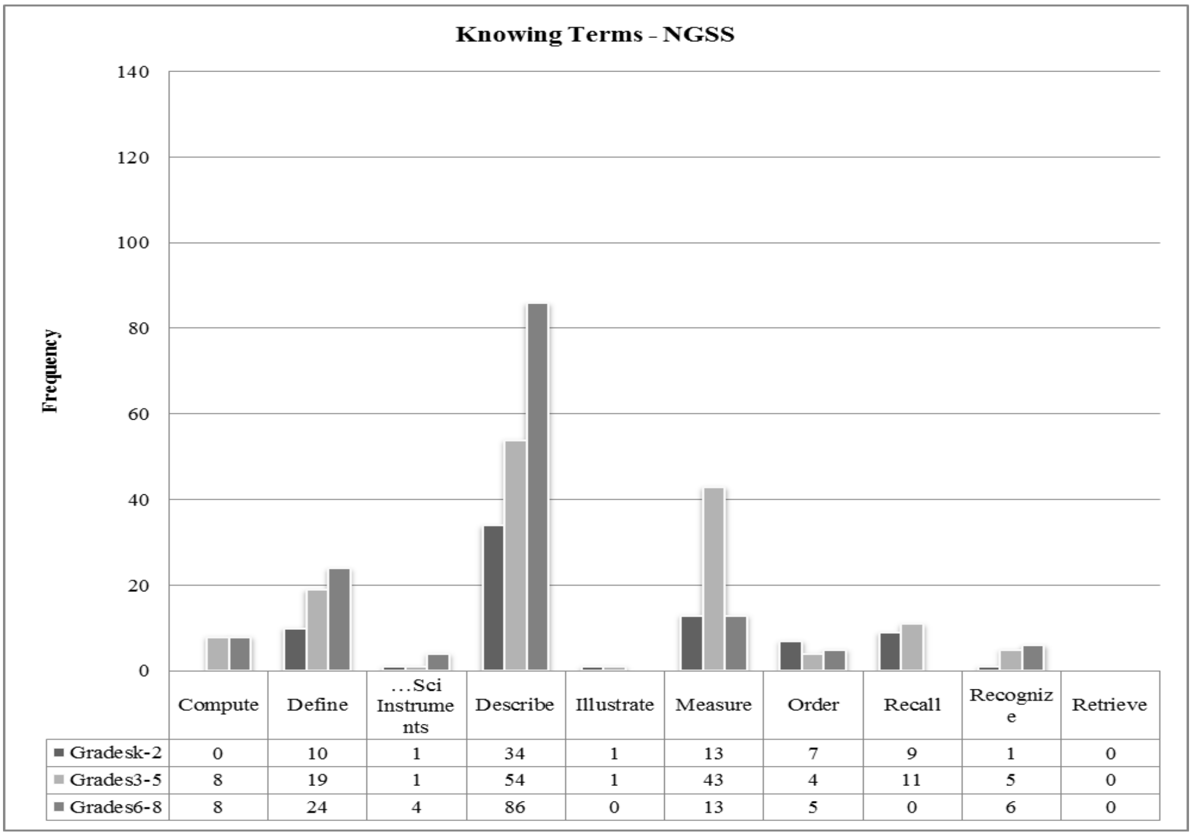



Figure 6. Terms in *Knowing* Category of NGSS

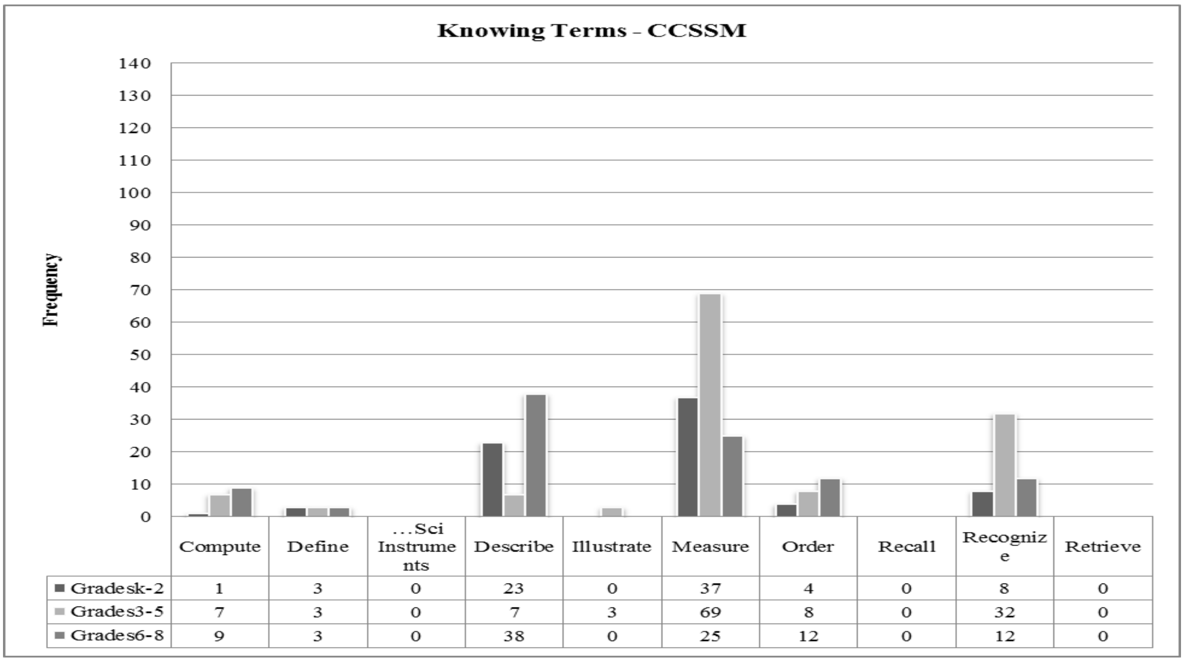



Figure 7. Terms in *Knowing* Category of CCSSM

The word Describe is one of the most commonly used terms in the *Knowing* domain. Within NGSS there is a steady increase as the grade bands progress with 34 (5.4%) mentions in K-2, 54 (5.2%) mentions in 3-5, and 86 (7.6%) mentions in the grades 6-8. Within the CCSSM, Describe is emphasized more so in the K-2 and 6-8 grade bands with 23 (9.1%) and 38 (8%) mentions respectively. A dip in the middle is observed where term is only referenced 7 (1.4%) times in the 3-5 grade band.

Table 5: *Practice Word Inventory-Raw (Proportions)*

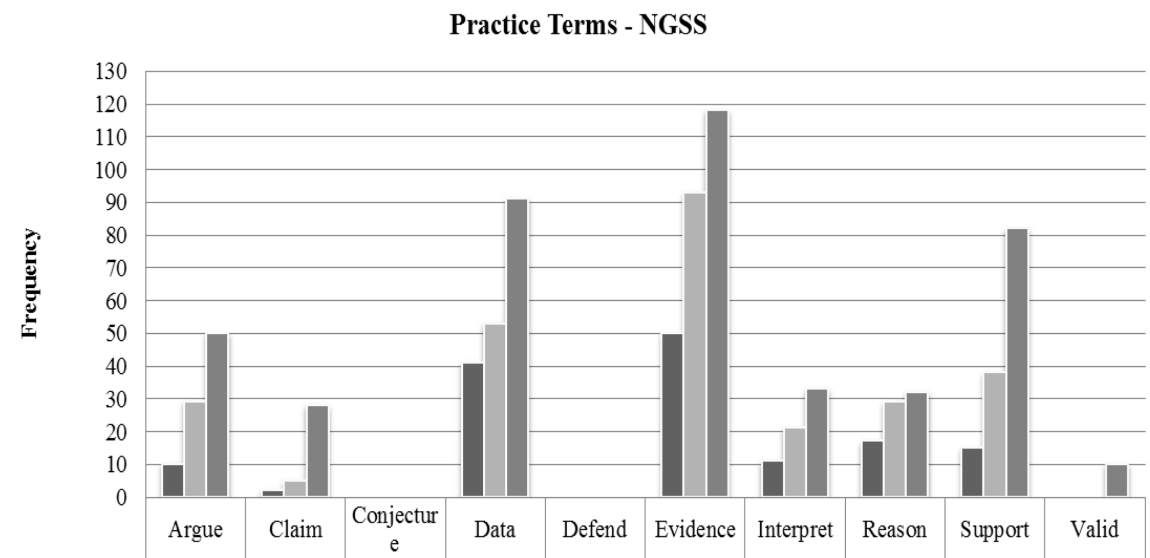
| | Grade | | |
|---|---|---|---|
| Word | K-2 | 3-5 | 6-8 |
| **Argue** | | | |
| NGSS | 10 (0.016) | 29 (0.028) | 50 (0.033) |
| CCSSM | 3 (0.012) | 4 (0.008) | 5 (0.010) |
| **Claim** | | | |
| NGSS | 2 (0.003) | 5 (0.005) | 28 (0.052) |
| CCSSM | 0 (0) | 0 (0) | 0 (0) |
| **Data** | | | |
| NGSS | 41(0.006) | 53 (0.052) | 91 (0.06) |
| CCSSM | 14 (0.055) | 17 (0.034) | 36 (0.079) |
| **Evidence** | | | |
| NGSS | 50 (0.081) | 93 (0.090) | 118 (0.079) |
| CCSSM | 0 (0) | 0 (0) | 1 (0.002) |
| **Interpret** | | | |
| NGSS | 11 (0.098) | 21 (0.020) | 33 (0.022) |
| CCSSM | 5 (0.020) | 25 (0.050) | 21 (0.0041) |
| **Reason** | | | |
| NGSS | 17 (0.126) | 29 (0.028) | 32 (0.014) |
| CCSSM | 19 (0.075) | 26 (0.051) | 24 (0.046) |
| **Support** | | | |
| NGSS | 15 (0.150) | 38 (0.065) | 82 (0.076) |
| CCSSM | 1 (0.004) | 0 (0) | 1 (0.002) |
| **Valid** | | | |
| NGSS | 0 (0) | 0 (0) | 10 (0.007) |
| CCSSM | 0 (0) | 3 (0.006) | 2 (0.004) |

The term Recall is not stated often in NGSS at only 20 total times, and is notably not mentioned at all in the CCSSM. Finally, Recognize appears in NGSS 12 times across the three bands. Recognize is mentioned in the

CCSSM's K-2 grade band 8 times (3.1%), but jumps to 32 (6.4%) mentions in the 3-5 band, and then drops down to only 12 (2.3%) references in the 6-8 grade band.

### *Additional Domain: Practice*

The numeric and proportional summaries of all the terms in the *Practice* domain can be found in Table 5. An aggregated bar graph for the terms in this domain can be found in Figures 8 and 9. The terms Interpret and Reason are emphasized consistently throughout the grade bands and between the standards.



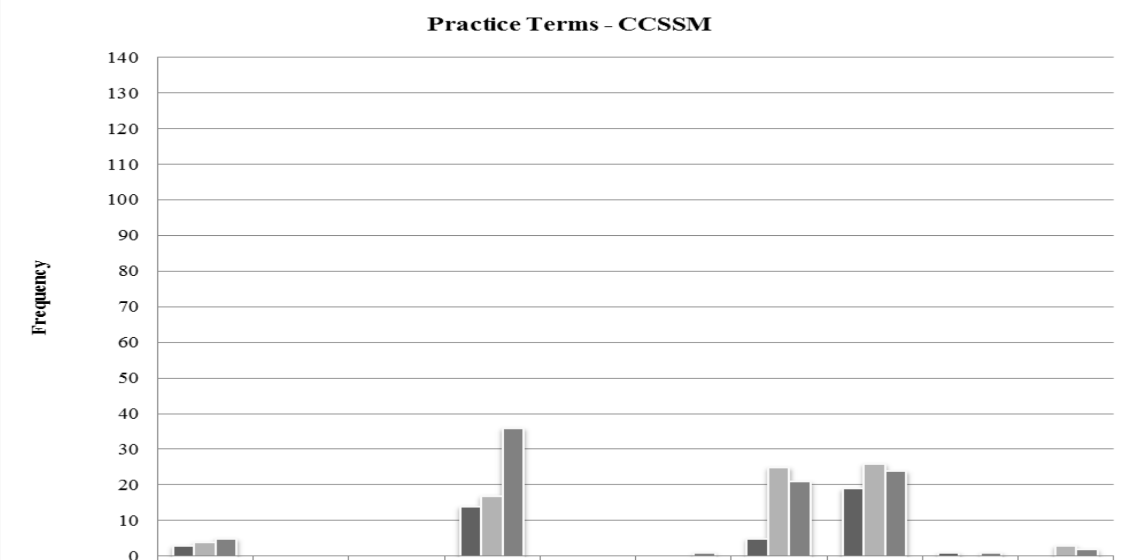

| | Argue | Claim | Conjecture | Data | Defend | Evidence | Interpret | Reason | Support | Valid |
|---|---|---|---|---|---|---|---|---|---|---|
| Gradesk-2 | 10 | 2 | 0 | 41 | 0 | 50 | 11 | 17 | 15 | 0 |
| Grades3-5 | 29 | 5 | 0 | 53 | 0 | 93 | 21 | 29 | 38 | 0 |
| Grades6-8 | 50 | 28 | 0 | 91 | 0 | 118 | 33 | 32 | 82 | 10 |

Figure 8. Terms in *Practice* Category of NGSS

The term Argue is more noticeable in its increase across grade levels in the NGSS than in CCSSM. In NGSS, Argue is referenced 10 (1.6%) times in K-2, 29 (2.8%) times in 3-5, then 50 (3.3%) times in the 6-8 grade band. In CCSSM, this same word is mentioned 3 (1.2%), only 4 (0.8%), then 5 (1%) times as the grade bands increase indicating little emphasis on the term Argue in this document. Claim, not mentioned even once in CCSSM, is used 2 (0.3%) times in the earliest grade band, only 5 (0.5%) times in the middle grade band, and then is used 28 (5.2%) times in the oldest grade band.

The term Data by the raw counts increase in both NGSS and CCSSM as the grade levels increase but NGSS includes greater numbers of references. It is noted that the proportional comparison makes this pattern look curved rather than a linear increase for CCSSM. In NGSS, the K-2 band contains the term 41 (0.6%) times. The 3-5 band contains the term 53 (5.2%) times. The 6-8 band contains the term 91 (6%) times. The term, in CCSSM is used 14 (5.5%) times in the K-2 grade band, 17 (3.4%) in the 3-5 grade band, and 36 (7.9%) times in the 6-8 grade band. The next term, Evidence, is emphasized in dramatically different ways between the two sets of standards. It is mentioned 1 time total in the CCSSM 6-8 grade band. Whereas in NGSS, it is used 50 (8.1%) times in K-2, 93 (9%) times in 3-5, and 118 (7.9%) times in 6-8.

In a similar way, Support is also emphasized differently between NGSS and CCSSM. In the early K-2 grade band, it is used 15 (2.4%) times in NGSS and only 1 (0.4%) time in CCSSM. In the 3-5 band, Support is used 38 (6.5%) times in NGSS and zero times in CCSSM. Lastly, in the 6-8 band, the term is used 82 (7.6%) times in NGSS and only 1 (0.2%) time in CCSSM.




| | Argue | Claim | Conjecture | Data | Defend | Evidence | Interpret | Reason | Support | Valid |
|---|---|---|---|---|---|---|---|---|---|---|
| Grades k-2 | 3 | 0 | 0 | 14 | 0 | 0 | 5 | 19 | 1 | 0 |
| Grades 3-5 | 4 | 0 | 0 | 17 | 0 | 0 | 25 | 26 | 0 | 3 |
| Grades 6-8 | 5 | 0 | 0 | 36 | 0 | 1 | 21 | 24 | 1 | 2 |

Figure 9. Terms in *Practice* Category of CCSSM

The last term in the *Practice* domain is Valid. Although there is relative consistency in emphasis given to this term both between standards and across grade bands, it is interesting that this term does not show up at all in NGSS until the 6-8 grade band where it is used 10 (0.7%) times. In the CCSSM, this same term is also not seen in the K-2 band but is used in the 3-5 band with 3 (0.6%) mentions, then 2 (0.4%) uses in the 6-8 grade band.

## Discussion and Implications

In addition to the inventory work by Assefa and Rorissa (2013) and Adualrob and Daniel (2013), the current study contributes to the field as it presents a typology for term analysis and subsequent findings within a terminology inventory. The findings indicate that there are numerous places where common terminology is aligned and used similarly both across grade bands and between the sets of standards. Conversely, many other terms within the four categories are used with varying degrees of emphasis both across grade bands and/or between the standards.

The different TIMSS domains: *Knowing*, *Applying*, and *Reasoning* plus the additional *Practice* domain serves as the organizing framework to guide terminology inventory and analysis of content expectations across the CCSSM and the NGSS. The standards, because they are so widely used in schools, offer a platform from which to facilitate the practice and potential transfer of learning. The occasions where the terminology is consistent between the standards and across grade bands could be opportunities where the transfer of learning organically manifests and the epistemological practices are starting to become what Hammer and colleagues (2005) refer to as routine; whereas the places where the terminology is either inconsistent in emphasis or where the definitions and intentions vary may make transfer of learning more difficult simply because of the barriers created by the choice of particular words.

Using specific language indicates particular practices or skills within disciplines. For example, "[a]rgument is essential to support or critique a model or explanation as well as its success or failure in explaining evidences about the phenomenon or system. Clearly, students must *obtain, evaluate, and communicate information* as they engage in the process of constructing and critiquing explanations" (Lee, Quinn, & Valdéz, 2013) throughout their learning and knowledge development experiences in their classroom settings. There exist evidence of common terminology use and frequencies that suggest that there are overlapping skills and cognitive demands across disciplines. From these data, it appears that the writers of both sets of standards expect students to do more and use the content in order to produce or take action in addition to their knowledge development, rather than simply repeat or report on their learning. By design, then, these standards invite transfer of learning, coinciding with Hakel and Halpern's (2005) statement that, "transferable learning goes beyond knowing to *doing* what one knows. That means demonstrating one's learning in performance" (p. 362). For instance, within the counts for the eights terms in the *Reasoning* domain, the most emphasized word is Design.

Some of the words within the previously established TIMSS cognitive themes have weak or little representation in the CCSSM and NGSS. The TIMSS is regarded as a significant body of work and thus it is puzzling that key terms germane to the TIMSS are not given more attention in the CCSSM or the NGSS documents. More research examining the inconsistencies between the TIMSS and the content standards in the U.S. would help tease out and clarify this issue. The twelve terms in the *Applying* domain are seen more frequently than those words contained in the other three domains. A similar pattern to what was referenced above – that the overall emphasis in the standards is that students apply or utilize their learning in effective and appropriate contexts. The attention dedicated to the *Applying* domain may hold implications for the transfer of learning across the mathematics and science disciplines as the previous research in this area have already begun to show. *Applying* students' knowledge in various ways is expected in both the mathematics and science arenas.

The overall word counts in the *Reasoning* domain are emphasized less than those in the domain of *Applying*. A concern articulated earlier arises again, as what is emphasized in TIMSS versus what is emphasized in the *Reasoning* category of terms in CCSSM and NGSS is inconsistent. The data from the terms under the *Practice* domain indicate that the NGSS emphasizes the terms Argue, Data, Evidence, and Support more so than CCSSM. This is probably unsurprising given the nature of scientific practice and the field's expectations of what students of science should be able to do. A similar emphasis on these terms may hold implications for practices that likely go together. For example, how are the terms Data and Evidence used differently? Are they actually referencing the same thing with simply a different word choice? Further examination in this area may offer additional insight.

Across grade bands, there are more places where the word counts are inconsistent. Only three of the twelve *Applying* terms are consistently seen in the standards across grade bands and are similarly emphasized in both the NGSS and the CCSSM. Only three of the ten terms within this domain are both consistently used across grade bands and are also similarly emphasized in the CCSSM and NGSS. In addition, only four of the 10 terms within this domain are regularly used in the standards across grade bands and are similarly emphasized in both NGSS and CCSSM. Future research could examine these irregularities to determine if the changes in term emphasis are due to cognitive development or something else.

A critical finding from these data is that the difference in expectations while using the same term in CCSSM and NGSS hold the potential for confusion or misinterpretation. Although not within the scope of this study, similar meanings and expectations that are attached to different word choices may be present within the standards but not accounted for as those specific words were not included in the 4-themed typology of the TIMSS + *Practice* used here. For the classroom teachers working to implement the standards with fidelity, we posit that most will or need to undergo a shift in the conceptual understanding and pedagogical approach to instruction and assessment of student progress in mathematics and science instruction. If students are invited to utilize their learning within a particular context, or discipline, and the classroom teacher deliberately creates a space to practice this application, might it then follow that the teacher could also design instruction in a way to facilitate transfer of learning to new contexts as previous research by Schwartz, Bransford, & Sears (2005) suggests? The transfer of skills and knowledge between disciplines is a viable goal of education. As educators, we want students to be able to use and apply their learning not only in the limited context of where they first encountered new information or skills, but also to be able to successfully employ them to appropriate contexts outside the original setting. Can this happen only if the documents are aligned with research in learning and cognitive development and aligned with each other?

Although Appendix A in the NGSS materials state that the science standards are aligned with the CCSSM, there are different places where the documents are asking students to engage in different cognitively demanding tasks. Should the standards, if they are aligned with each other and with what is developmentally appropriate, require students to meet similar objectives and engage in similar practices at the same stages of their schooling? In several places, they do not. For example, the CCSSM contains 8 *Reasoning* terms in K-2 but this same age group is asked to engage in the *Reasoning* domain 146 times in NGSS and 42 times in math in grades 6-8 but 368 times in science. We found these discrepancies interesting especially since existing research (e.g. Brogt et al., 2013; Frykholm & Glasson, 2005; Pang & Good, 2000) show the natural opportunities for and occurrences of transfer across mathematics and science learning.

Through the findings of this study, there is evidence that further exposes that these two disciplines use and understand the same vocabulary terms in different ways. In regards to curriculum policy then, this study leaves us asking questions such as: What are those things educators and curriculum policy makers need to be mindful of in regards to learning, teaching, and the promotion of instructional approaches that effectively support these differences in terminology use? Or what are those things educators and curriculum policy makers need to be mindful of in regards to the variances in cognitive expectations within the three grade bands? These are especially pertinent since elementary students are typically in the same classroom and taught by the same teacher regardless of the subject.

It follows that a significant challenge remains, which begs further examination in this area. The CCSSM and NGSS do not provide meanings for the terms they ask students to be able to do. Therefore, there is an assumption, by the creators of all the standards, that all educators will interpret the words the same way. Elementary teachers are primarily generalists, and because the same terms are found both in the CCSSM and NGSS, it is likely that the same definition and expectation will be tied to both. As research in the areas of mathematics and science education show, there are specific ways of operating and communicating in these distinct disciplines. Without supplementary materials to accompany CCSSM and NGSS, a potential for misinterpretation and following, miscommunication is perpetuated. Research about field expectations of particular words in the standards would help address this disparity.

As principals, teachers, and other stakeholders deepen their understanding of the standards' expectations and transfer of learning, in the current accountability era, the instructional changes and facilitation of these changes may more effectively serve as a tool for "new ways of thinking about transfer suggest new ways of thinking about assessments, and that working smart assessments are one example of a different paradigm that could have major effects on education and accountability" (Schwarts et al., 2005, p. 45). The inventory of words across the CCSSM and NGSS indicated that there are similar uses of language across the standards but notable differences in particular terms are also present and are thus in need of particular attention. These differences in specific use of terminology may stem from discipline, or field-specific, expectations for performance and learning. A problem arises if these differences are not recognized and adjusted for in pedagogy and practice. Because policy makers, school leaders, and other stakeholders promote and package the STEM fields as a holistic subject, these variable meanings and/or expectations reveal the potential for misguided expectations within the classroom as students, teachers, and principals use the same terminology in multiple, but distinct contexts.

As students navigate through the different disciplines, and classroom teachers adjust their instruction according to discipline, the recognition of the potential connections and places of diversion between science and mathematics can impact the decision making around instruction. Literature surrounding the CCSSM and the NGSS reveals that the adoption of the standards requires pedagogical understanding (Pratt, 2012; Pruitt, 2014; Wu, 2014) and capacity building (Darling-Hammond, Wilhoit, & Pittenger, 2014) for those educators charged with implementing them. Deepening the familiarity of the content standards may help teachers and school leaders make informed curricular and instructional decisions. Notably, "teachers should use practices true to the NGSS and diverse instructional strategies, drawing upon literacy and mathematical practices outlined in the Common Core State Standards (CCSSM) to reinforce the interconnected nature of science with other content areas" (Chiu et al., 2015, p. 11). An examination of the terminology is a worthwhile line of research since recognizing specific language connections across the standards could reveal relationships between and within disciplines.

The findings in this inventory and analysis may have particular relevance for those sites that adopt the CCSSM and NGSS and those that prioritize STEM education as the data reveal the emphasis of particular skills and expectations within student learning. Although this research prompts more questions for us in this line of research, we believe there are some notable takeaways from this work. From the data presented here, these findings hold implications for (1) future policy and curriculum analyses regarding the alignment of standards across disciplines; (2) future policy analysis regarding the alignment of assessments to these particular content expectation emphases; (3) the necessary capacity building for teachers and instructional leaders alike; (4) the exploration of the transfer of cognitive skills across disciplines; and (5) the evolution of epistemological to ontological practices and how this can be supported for students and how these practices will impact future curriculum policy decisions.

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