# Science Technology Engineering and Math (STEM) Education MUST Begin in Early Childhood Education: A Systematic Analysis of Washington State Guidelines Used to Gauge the Development and Learning of Young Learners

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Education

University of Washington

2015

Committee:

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Program Authorized to Offer Degree:

College of Education

University of Washington

## Abstract

Science Technology Engineering and Math (STEM) Education MUST Begin in Early Childhood Education: A Systematic Analysis of Washington State Guidelines Used to Gauge the Development and Learning of Young Learners

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This paper reflects future direction for early Science Technology Engineering and Mathematics (STEM) education, science in particular. Washington State stakeholders use guidelines including: standards, curriculums and assessments to gauge young children's development and learning, in early childhood education (ECE). Next Generation Science Standards (NGSS), and the Framework for K-12 programs (National Research Council, 2011) emphasizes the need for reconfiguration of standards: "Too often standards are a long list of detailed and disconnected facts… this approach alienates young people, it also leaves them with fragments of knowledge and little sense of the inherent logic and consistency of science and of its universality." NGSS' position elevates the concern and need for learners to experience teaching and learning from intentionally designed cohesive curriculum units, rather than as a series of unrelated and isolated lessons. To introduce the argument the present study seeks to examine Washington State early learning standards. To evaluate this need, I examined balance and coverage/depth. Analysis measures the level of continuum in high-quality guidelines from which Washington State operates to serve its youngest citizens and their families.

**A systematic analysis of WA guidelines in ECE can aim for meaningful science experiences for young learners**

The conceptual orientation of this study is described to present underpinnings to better understand the need for STEM in ECE and for WA state standards to mobilize supports for teaching and learning, creating successive steps yielding later success. Engeström (1987) posits "contradictions and tensions are the engines of change and transformation in practices, tools, and activities." Thus, contradictions or disturbances within and across age cohorts could advance the conversation on how to inform reconfigurations of WA state standards. The objectives of this study are to examine: (1) To what extent do standards demonstrate a developmental progression, birth through age six? (2) To what extent do standards prepare young learners for NGSS Science kindergarten expectations? (3) The extent to which two documents (HSCDELF/WA-ELG, HSCDELF/NGSS, and WA-ELG/NGSS) align when comparing age groups (preschool to kindergarten), and (4) Whether there are science benchmarks absent from standards that should be considered and included? In the continuous sections below, I discuss: (1) Why ECE matters? (2) Why early STEM is important? and (3) Why standards are important in ECE?

**The Importance of Focusing on the Early Years**

A critical time to invest efforts for child development and cognition is from birth to age five. The human brain is developing rapidly in this time and it is the critical time to build the foundation for character and skills necessary for success (Heckman, 2011). Research suggests neuron development happens before birth; babies a day old can tell differences in the language heard while in-utero from other languages (Moon *et al.*, 2013). Similarly, neuroscience and brain development marks new connections being formed during early stages, when the brain is "plastic," i.e., flexible or changeable. The connections most used are retained and strengthened; while connections that are unexercised or unused are pruned, disappearing before the age of five

(Huttenlocher, 1990). Findings in neuroscience and brain development indicate the best opportunity for teaching and learning happens early on. If investment to design meaningful learning experiences does not happen early on, we miss an opportunity to teach foundations for later success. ECE can cultivate cognitive skills along with attentiveness, motivation, sociability and emotional development, to guide learners to success, taking the perspective of the whole child.

The Heckman Equation equates gain to the combined efforts of investment, development and sustainment.

> **Gain:** more capable productive and valuable citizens that pay dividends to America for generations to come. **Investment:** in educational and developmental resources for disadvantaged families to provide equal access to successful early human development. **Development:** cognitive skills and social skills in children early – from birth to age five when it matters most. **Sustainment:** early development with effective education throughout adulthood. (Heckman, 2011).

Investing in early steps leads the way for child outcomes, readiness for kindergarten success and beyond (Heckman, 2012). One in three children begin kindergarten without the basic language skills they need to learn and read (Bay Area Council, 2014). The concern then is: who is at risk? A study measured the number of words babies hear per hour: professional families (2,153), working class families (1,251), and families that apply for welfare (616). By age three there is a 30 million-word gap (Hart and Risley, 2003). In response, a recent study extends our understanding of what factors are important for later success, finding that "quality" of words, not "quantity," is crucial for literacy development (Friedman *et al*., in press). The need is not to delineate a dichotomous case for "good" and "bad," but rather, what affordances and constraints are present in attending to quality and quantity and their correlations with child learning outcomes.

An analysis of the research literature indicates specific skills and abilities of children ages birth through five years that predict later reading outcomes, including oral language, alphabetic code, and print knowledge/concepts (Srtickland *et al.*, 2003; Storch *et al.*, 2002; Strickland *et al.*, 2004). Literacy can be a powerful way to develop and resource STEM practice skills in children. Morrow (1997) found that children in a literature/science group performed significantly better in literacy than children in the literacy only group, or control group. What, why, and how are STEM experiences being afforded to young learners?  Bringing back the number of words heard (Hart and Risley, 2003) and quality (Friedman *et al*., in press) of words; research suggests that the relationship between literacy and STEM is not only binary, but interwoven.

Early STEM is a platform to design learning, stemming manifold experiences by tapping into the potential of cross-cutting concepts, including literacy. STEM professionals make meaning of the world around them in collaboration, in team surroundings. The benefits of including STEM into ECE generate compound effects; cognitive development and character skills can be practiced and strengthened.

*US rankings on international STEM student assessment elevate the importance to design STEM learning opportunities for young learners (PISA, 2012; National Center for Education Statistics, 2011; Office of the Press Secretary, 201)*

STEM workers drive the nation's innovations and competitiveness by generating new ideas, new companies and new industries. In a growing technology based society, statistics over the past 10 years show the number of STEM jobs grew three times faster than non-STEM jobs. In the next 10 years the Bureau of Labor Statistics expects the United States to create 9.2 million jobs in STEM fields (Committee on Education and the Workforce, 2013). While the minority population in our country continues to climb, the number of underrepresented students who graduate from college prepared for a science, engineering, technology and math (STEM) career is dishearteningly small. If current trends continue, by 2050 almost half of the U.S. population will be nonwhite (Committee on the Engineer of 2020 PI, Committee on Engineering Education, National Academy of Engineering, National Research Council, 2005). In the period August 2010-July 2011, minorities made up 50.4% of US births (Yen, 2012). The percentage of minority children has increased from 31% in 1990 to 46% in 2010 (O'Hare, 2011). The most notable increases between 2000 and 2010 of the population 18 and younger are for children of mixed race (46%), Hispanics (39%) and non-Hispanic Asian and Pacific Islanders (31%) (O'Hare, 2011). In Washington State, in 2013 Hispanics made up roughly 20% of children 18 and younger (United States Census Bureau, 2014). Washington State also has a relatively large population of Alaska Indians/American Natives (AI/AN), about 1.3% of the population. Combined with Oregon and Idaho, the Pacific Northwest is home to approximately 206,000 (6.7%) of the nation's federally-enrolled tribal members (National Science Board, 2008)

For the purpose of this study, underrepresented minorities, or URMs, are defined as African Americans, Hispanics and Alaska Indians/American Natives. URMs make up 29% of the U.S. population, but only account for 11.3% of the STEM workforce ( National Science Board, 2008) outside of universities (United States Census Bureau, 2009). From 2000-2020, the non-Hispanic labor force is expected to grow by 9%, while the Hispanic labor force will grow by 77% (Suro *et al.*, 2003). Tremendous disparities still exist in the educational achievements of different ethnic groups, and changing demographics will create a significant future workforce problem in STEM.

In 2012, the Programme for International Student Assessment ranked students in the United States 27th out of 34 countries in mathematics and 20th out of 34 in science (PISA, 2012). "While the U.S. spent more per student than most countries, the trend data show no significant changes in the average performance of the U.S. 15-year-old students in mathematics, reading and science over time" (PISA, 2012). Similarly, data from the International Mathematics and Science Study ranked 4th graders' science achievement 47th out of 57 countries, with "no measurable difference between the U.S. average science score at grade 4 in 1995 and in 2011" (National Center for Education Statistics, 2011). To address these bleak statistics, President Barack Obama announced the Educate to Innovate initiative, which aims to increase the number and quality of students in science, technology, engineering, and mathematics (Office of the Press Secretary, 2012). In order for the United States to meet the labor demand and compete with international markets in research and innovation, our educational systems require a turning point. Investments in research that extend knowledge and understanding focused on equity and increasing student diversity in STEM advances the conversation on how to best approach cognition and development (Heckman, 2012).

Warren and Halpern-Manner's (2007) research on graduation achievement suggests the magnitude and direction of the high school dropout problem has been understated: "one in four high school students fail to obtain a high school diploma and that about half of Hispanics and non-Hispanics Blacks fail to do so" (Warren and Halpern-Manner, 2007). A milestone that is considered to be the best predictor for high school graduation rates can be determined by third grade – 80% of low-income students are not proficient readers by this time. The estimated return of investment in early learning is 7 dollars for every dollar spent in ECE (Heckman, 2011). This elevates the concern and need for ECE investment and intervention. STEM, specifically math and science, coupled with early literacy are pathways to develop content knowledge and practice skills early on for young learners (National Research Council, 2014).

Warren and Halpern-Manner (2007) provide alarming graduation statistics coupled with predictors of success in ECE, supplementing the prerequisite to invest, develop, and sustain efforts to acquire gains in the lives of citizens. Early STEM education is an enriched space, with cross-cutting concepts, mobilizing and meeting requirements to design successive steps towards foundational steps, providing learners with appropriate tools to succeed.

**ECE STEM literature review: Research to advance the conversation of young learners as scientists**

*Young learners learn about the world much like scientists do*

Researchers now suggest that the opportunity to engage in science learning during the preschool years lays an important foundation for later success in school (National Scientific Council on the Developing Child (2007); National Research Council (2014)). The National Research Council (Committee on Early Childhood Pedagogy, 2001) reports that a preschool curriculum that promotes skills such as reflecting, predicting, questioning, and hypothesizing is most effective for engaging young learners. Research in science learning advances the conversation to empower children as much more capable learners than previously thought (Gopnik, 2010). Gopnik presents 24 month olds doing statistics by looking at and analyzing the patterns around them and using statistics to figure out how the world around them works. Legare *et al.* (2014) show children are also doing experiments much like scientists do; through exploration and explanation children try out and test hypotheses (Bay Area Council, 2014). Similarly, analyzing the use of two blocks to make a blicket detector function (light up), Gopnik (2010) shows that “four-year-olds were better than adults at grasping unusual causal structure.” Adults relied more on their prior academic knowledge, causing them to believe that a device functions only in one way, rather than observing and analyzing facts that were in front of them.

Children in this study were creating hypotheses and asking why questions to learn about the world, much like scientists do.

*Science curricula and standards*

Early foundations in science help young children be engaged and to make sense of the world around them. Greenfield *et al.* (2009) reviewed the content and process focuses of 29 national and state pre-kindergarten/kindergarten science standards and 10 early childhood curricula. The review of national science standards produced a list of content and topic areas as well as process skills that children are expected to learn before entering grade school. Three broad content areas emerged: Life Sciences (42% of all entries), Earth/Space Sciences (27%), and Physical/Energy Sciences (31%). In terms of expectations for preschool children to engage in critical thinking, 8 skills emerged: observing, describing, comparing, questioning, predicting, experimenting, reflecting, and cooperating (Greenfield *et al*., 2009). Table 1 lists all science benchmarks and their definitions.

La Paro *et al.* (2009) show the opportunities to learn across disciplines in preschool classrooms. On average, "preschoolers spent 6% of time in mathematics, 7% in science, and 14% in literacy activities, with time devoted to science decreasing and time devoted to mathematics and literacy increasing as these children moved to kindergarten, 11%, 3%, and 28% respectively" (La Paro *et al.*, 2009). Similarly, Connor *et al*. (2006) reported that on average, preschoolers spent about 4 min per day on mathematics and 3 min per day on science, whereas 15 min were devoted to language and literacy. Research by Tu (2006) focused primarily on formal and informal preschool science instruction, finding that out of 120 min, only 4.5% of activities were dedicated to formal science, and 8.8% to informal science. In other words, 86.7% of the activities were unrelated to science. If opportunities for science learning are not being afforded for children, what factors are contributing to this statistic?

*The importance of teacher perceptions on student science learning*

Piasta *et al.* (2014) outlined that the variability in the amounts and types of mathematics and science learning opportunities for children were associated with teachers' years of experience, teachers' levels of education, and the socioeconomic status of children served in the program. Research suggests that the relationship between preschool teacher candidates' attitudes towards science can shape children's engagement in science and developing their scientific curiosity (Blown, 2012; Çakmak, 2012; Spektor-Levy *et al.*, 2013). Out of 146 pre-school teachers, most believe that science education should begin in early childhood. Some teachers believed that very young children can investigate and take part in a process of inquiry and scientific activities in preschool that can influence long-term attitudes toward science. Teachers were worried about not having full content knowledge on the subject, unsure of how to engage children and how to meet children's needs.

Teachers' experiences and education impact the types of learning experiences designed for young learners (Piasta *et al.*, 2014). To better understand science in preschool, Peterson and French (2008) examined how teachers support children's explanations through science inquiry. The purpose of their study is to examine discourse and expressive language centered on color-mixing activities. Structured activities narrow "concept development, quality feedback, and language modeling" and in turn undermine young learners' capabilities to learn science in authentic ways, as scientists. The study attempts to emphasize how hard it is to teach and engage learners with science inquiry skills. Eberback and Crowley (2009) emphasized how observation on the surface can appear to be a simple skill, consequently, "children may be directed to observe, compare, and describe phenomena without adequate disciplinary context or support, and so fail to gain deeper scientific understanding." The question becomes: how are ECE educators being supported to meet the needs of children when it comes to learning science?

In summary, ECE matters as it is critical time for young learners, birth to five, to develop cognitive and character skills for later success (Huttenlocher, 1990; Heckman, 2011). Early STEM is a platform to design learning settings to practice cognitive skills, science benchmarks, and character skills. The need for inclusion of STEM into ECE places is constructive. It addresses the alarming graduation statistics for low-income learners (Warren and Halpern-Manner, 2007) and, early on develop skills in literacy in cross-cutting concepts to improve graduation achievements.

**Washington State guidelines: Supports for teachers on teaching and learning of young learners**

*Standards*

U.S. stakeholders prepare standards that outline the fundamental building blocks of education to be universally understood and adopted by states. At the national level, The Head Start Child Outcome Framework (Office of Head Start, 2010) is a source to support states on how to guide parents, providers, researchers and policy stakeholders to make decisions on how to shape learning for young children. Each state has the choice to create their own standards. State standards or guidelines are a platform for parents and providers to identify where a child should be developmentally. They also function as a resource for instruction and decision-making criteria for programs to select a comprehensive curriculum. Because high quality early learning experiences are so important, they cannot be left to chance. In Washington State, Early Achievers (EA) is a quality rating and improvement system (QRIS) that evaluates child care providers and offers coaching and resources to teachers to provide and support learning and development for children to succeed in school and beyond. Washington State investment in ECE is a critical first step in advancing the conversation and need for ECE supports (Washington State Department of Learning, Visited 2014).

**Conceptual framework to address the current state of science in ECE**

Stakeholders use standards as the drivers to deliver the foundational building blocks for early learning and to gauge the development of young children's competencies and learning. With the many stakeholders in ECE, the pressing need is to assess the degree to which such standards align. It is also critical to identify and investigate disturbances to steer improvement efforts that better support the success of our youngest citizens. Current research has set foregrounding steps as the innovative drivers by which to best measure the degree of alignment by conducting both "vertical" and "horizontal" evaluations (Kagan *et al.*, 2009, 2011, 2013; Scott-Little, 2011). These breakthrough investigations provide a schema for researchers to identify, label and examine disturbances where it is harder for learners to succeed. Examining disturbances allows us to direct efforts to best support the development and success of more young children.

**Present study and research questions**

The standards under review are: Washington State Early Learning and Development Guidelines (WA-ELGs) developed in 2012, The Head Start Child Development and Early Learning Framework (HSCDELF) revised in 2011, and Next Generation Science Standards (NGSS) implemented in 2013. Table 2 shows a pictorial representation of each standard.

The objective of this study is to examine the following research questions: (1) To what extent do standards demonstrate a developmental progression, birth through age six? (2) To what extent do standards prepare young learners for NGSS Science kindergarten expectations? (3) The extent to which two documents (HSCDELF/WA-ELG, HSCDELF/NGSS, and WA-ELG/NGSS) align when comparing age groups (preschool to kindergarten), and (4) Whether there are science benchmarks absent from standards that should be considered and included? This research specifically takes into consideration Greenfield *et al.*'s (2009) preschool science benchmark expectations.

The first question will be examined by conducting a balance analysis. Balance evaluates the percent of science benchmarks within standards. Data will be discussed in two formats: balance of standards as a whole, and by age. Next, to determine the extent to which standards prepare young learners for NGSS kindergarten expectations; I will conduct a "vertical alignment" analysis. Vertical alignment measures the consistency of standards between age cohorts (preschool vs. kindergarten). I will consider match, how well indicators align, and "Coverage/Depth" parameters. Coverage/Depth will measure the percentage of all indicators represented across science benchmarks. Lastly, throughout the analysis, I will evaluate what science benchmarks are absent, or misaligned, for standards that should be considered for inclusion. Sections below discuss materials, procedures and analysis in detail.

It was predicted that examining standards would bring forth contradictions or disturbances, inter and intra guidelines. These contradictions transform new knowledge improvement efforts to best increase breadth of science experiences to reach young learners. It is also noted that collaboration within and among guidelines is rarely cited, professional development to support ECE professionals in STEM are yet to be created.

**Materials and Procedures**

To analyze the content of WA State guidelines used by providers, the standards were printed and compiled into binders. The first step was to determine what science experiences young learners are expected to do, i.e., science benchmarks. Next, I reviewed the standards to examine what science benchmarks are represented (see Table 1 for a list of science benchmarks and their definitions).

*Science practices that engage young learners*

Early foundations in science help young children be engaged and to make sense of the world around them. The National Research Council (Committee on Early Childhood Pedagogy, 2001) reports that a preschool curriculum that promotes skills such as reflecting, predicting, questioning, and hypothesizing is most effective in engaging young learners. Greenfield *et al.* (2009) reviewed the content and process focuses of 29 national and state pre-kindergarten/ kindergarten science standards and 10 early childhood curricula. The review of national science standards produced a list of content and topic areas as well as process skills that children are expected to learn before entering grade school. Three broad content areas emerged: Life Sciences (42% of all entries), Earth/Space Sciences (27%), and Physical/Energy Sciences (31%). In terms of expectations for preschool children to engage in critical thinking, 8 skills emerged: observing, describing, comparing, questioning, predicting, experimenting, reflecting, and cooperating (Greenfield *et al*., 2009). Table 2 lists all science benchmarks and their definitions.

*Washington State standards to support ECE professionals*

The standards under review are: Washington State Early Learning and Development Guidelines (WA-ELGs), The Head Start Child Development and Early Learning Framework (HSCDELF), and Next Generation Science Standards (NGSS). Table 2 shows HSCDELF, WA-ELG and NGSS age and standard alignment.

*Washington State Early Learning and Development Guidelines (WA-ELGs)*

Washington State Early Learning and Development Guidelines (Washington State Department of Early Learning, 2012) are guidelines for children birth through third grade. The Guidelines build bridges between families, birth through age five caregivers/educators, K-12 educators, and other professionals serving children. They "align with the State Early Learning Plan, and reflect federal, state, and Tribal learning standards" (Washington State Department of Early Learning, 2012). The Guidelines support the standards of the Early Childhood Education and Assistance Program (ECEAP) and Head Start standards, and provide meaningful connection to the state's learning standards for kindergarten through third grade, including Common Core Standards. The Guidelines are organized by areas of development: About me and my family and my culture; Building relationships; Touching, seeing, hearing and moving around; Growing up healthy, Communicating; and Learning about my world. These six areas of development are described by activities, behaviors, skills, or ability development across ages.

In a review of WA-ELGs, science process skills were found under the Learning about my world area of development. The two activities: Knowledge (cognition) and Science were reviewed for each age group, from birth through six year olds. Tables 3-8 show the activities with corresponding behaviors, skills, or ability development across ages. I used Greenfield *et al.*'s (2009) eight process skills to do a concept alignment, matching WA-ELGs behavior with appropriate skills. Tables 3a-8a show science benchmark frequency counts for each activity: Knowledge (cognition) and Science.

*The Head Start Child Development and Early Learning Framework (HSCDELF)*

The Head Start Child Development and Early Learning Framework (Office of Head Start, 2010) serves children from birth to five. The framework aligns and builds from the five essential domains: Approaches to learning; Social and emotional development; Language and literacy;

Cognition; and Perceptual, motor and physical development, to identify critical areas of learning and development for children ages three to five. The Head Start Framework Wheel is organized by Domain and Domain Elements, beginning from younger age groups (birth to three year olds), and extending to older age groups (three to five year olds). Science Knowledge & Skills is the science domain, divided in two domain elements: Science Skills & Methods, and Conceptual Knowledge of the Natural and Physical World.

In review of HSCDELF, science process skills were found in the Domain: Science Knowledge & Skills. The lists of abilities under each domain were reviewed. Table 9 shows domain elements with the corresponding list of abilities. I used Greenfield *et al.*'s (2009) eight process skills to do a concept alignment, matching HSCDELF behavior with appropriate skills. Table 9a shows science benchmark frequency counts for each domain element.

*Next Generation Science Standards (NGSS)*

Next Generation Science Standards (Next Generation Science Standards, 2015) are a new set of standards for science education throughout all grades, K-12, with an emphasis on engineering and science. Washington State was one of the first ten states to adopt the standards, called Washington State 2013 Science Learning Standards. NGSS describe what each student should know in the four domains of science: physical science; life science; earth and space science; and engineering, technology and science application. NGSS standards are aligned with Common Core State Standards. The objective is "when students are learning about science, they are also enhancing their skills in reading, writing, and math."

In review of NGSS, science process skills were found in four content areas: Forces and interactions: Pushes and pulls; Interdependent relationships in ecosystems: Animals, plants and their environments; Weather and climate; and Engineering design. Each of these content areas had three elements: Science and Engineering Practices; Disciplinary Core Ideas; and Causes and Effects with corresponding indicators. Tables 10-13 show the content area, elements and indicators. Again, I used Greenfield *et al.*'s (2009) eight process skills to do a concept alignment, matching NGSS indicators with appropriate skills. Table 10a-13a shows science benchmark frequency counts for each element.

**Analysis**

The standards under review are: WA-ELG, HSCDELF, and NGSS. I will conduct a "vertical alignment" to examine the consistency of standards. I will evaluate two parameters: "coverage/depth" and "balance." The analysis of standards is separated into two segments. In the first segment, coverage/depth evaluates the percentage of indicators represented across science benchmarks when comparing age cohorts. Discussed are the following seven deliverables:

*Deliverable I: HSCDELF Ages 3-5yrs to WA-ELG Ages 3-4yrs*

*Deliverable II: HSCDELF Ages 3-5yrs to WA-ELG Ages 4-5yrs*

*Deliverable III: HSCDELF Ages 3-5yrs to WA-ELG Ages 5-6yrs*

*Deliverable IV: HSCDELF Ages 3-5yrs to NGSS Ages 5-6yrs*

*Deliverable V: WA-ELG Ages 3-4yrs to NGSS Ages 5-6yrs*

*Deliverable VI: WA-ELG Ages 4-5yrs to NGSS Ages 5-6yrs*

*Deliverable VII: WA-ELG Ages 5-6yrs to NGSS Ages 5-6yrs*

To evaluate the alignment, I will take into consideration percent "match." Match determines how well indicators align by each science benchmark and overall, as a whole. The aim is to determine the extent to which the two documents, HSCDELF and WA-ELG, align, preschool to kindergarten. The objectives are:

(1) to evaluate the extent to which the two documents align when comparing age groups (preschool to kindergarten)

(2) to evaluate the extent to which standards prepare young learners for NGSS kindergarten science expectations; and

   a. to identify science benchmarks that are absent that should be considered for inclusion

Next, I examine the extent to which standards addresses the science benchmarks, i.e., balance. The aim is evaluate the developmental progression for science benchmarks. Discussed are the two following deliverables:

*Deliverable VIII: WA-ELG Science Benchmarks Developmental Progression across Age Cohorts*

*Deliverable IX: WA-ELG, HSCDELF, and NGSS Science Benchmarks Counts by Age Cohorts*

The objectives are:

(1) to evaluate the extent that standards' indicators show a developmental progression, from birth to six years old;

   a. to identify science benchmarks that are absent that should be considered for inclusion

(2) to examine WA-ELG (Ages 3-4 yrs, 4-5 yrs, and 5-6 yrs) and HSCDEFL (Ages 3-5 yrs) in comparison to NGSS (Ages 5-6 yrs) kindergarten expectations

   a. to identify science benchmarks that are absent that should be considered for inclusion

These analyses examine how documents prepare young learners for science experiences and identify science benchmarks that are absent that should be included.

*Vertical Analysis: Coverage of Standards*

To calculate coverage/depth of each science benchmark and the documents as a whole, I first summed counts across science benchmarks per document. Next, I summed the total count number for each science benchmark, across documents (see Tables 1a-7a). Then to calculate level of alignment, I divided counts per science benchmark by the total (e.g. Observe Counts for Document A/ (Observe Counts for Document A + Observe Counts for Document B)). See Table 1b-7b for calculations of percentage of indicators represented across science benchmarks. Lastly, to discuss levels of alignment, science benchmarks are coded by color: Blue ≥ 0-25%, Green < 25-50%, Yellow < 50-75%, and Red ≤ 75-100%. The color scheme represents: best aligned (Blue), aligned (Green), somewhat aligned (Yellow), misaligned (Red) (see Table 9a).

*Vertical Analysis: Balance of Standards*

To calculate the balance of documents by age, I summed the total count number for individual benchmarks, across documents (see Table 8a for calculations). To calculate percentage of indicators represented across science benchmarks by age, I divided counts per science benchmark by the total (e.g. WA-ELG B-11 mo Observe Counts for Document A/ WA-ELG B-11 mo Total Counts). See Table 8b for calculations.

To determine if WA-ELG and HSCDELF meet NGSS expectations, I divided counts per science benchmark of WA-ELG and HSCDELF by NGSS counts. For example, WA-ELG counts for observe/ NGSS counts for observe. Science benchmarks are color coded: Blue ≤ 75-100%, Green < 50-75%, Yellow < 25-50%, and Red ≥ 0-25%. The color scheme represents: exceeds expectations (Blue), meets expectations (Green), somewhat meets expectations

(Yellow), does not meet expectations (Red) (see Table 9b). Figure 9b shows how standards, WA-ELG and HSCDELF, meet NGSS kindergarten science expectations.

**Results and Discussion**

*Vertical Analysis: Coverage of Standards*

Coverage/depth evaluates the extent to which the two documents align with one another. The objective of Deliverables I-III is to examine the consistency of science benchmarks of WA-ELG guidelines in comparison to HSCDELF. Coverage/depth evaluates match or alignment. Alignment of individual science benchmarks and as a whole is measured by percentage of indicators. The objective of Deliverables IV –VII is to examine the extent to which WA-ELG and HSCDELF standards prepare young learners for kindergarten expectations, or NGSS. The purpose of alignment is to identify the extent to which science benchmarks are represented to measure consistency. The aim is to evaluate the percentage of science benchmarks represented to identify strengths and needs for improvement, across documents.

Figures 1-7 show percentage of indicators represented for individual and overall science benchmarks, as well as percent misalignment. Tables 1a-7a show counts across science benchmarks. Tables 1b-7b show percentage of counts across science benchmarks. Table 9a shows science benchmarks and documents as a whole, coded by colors: Blue ≥ 0-25%, Green < 25-50%, Yellow < 50-75%, and Red ≤ 75-100%. The color scheme represents: best aligned (Blue), aligned (Green), somewhat aligned (Yellow), misaligned (Red). Table 9a shows the extent of science benchmarks' alignment.

Deliverables I-III examine science learning for WA-ELG age cohorts (3-4 yrs, 4-5 yrs, 5-6 yrs) in comparison to HSCDELF (3-5yrs). As WA-ELG age cohorts increase, alignment decreases when compared to HSCDELF. Important findings are:

*Deliverable I: HSCDELF Ages 3-5yrs to WA-ELG Ages 3-4yrs*

- Describe, Question and Reflect are best aligned (Blue ≥ 0-25%)
- Predict is aligned (Green < 25-50%)
- Observe and Compare are somewhat aligned (Yellow < 50-75%)
- Experiment and Cooperate are misaligned (Red ≤ 75-100%)
- Overall, somewhat aligned (Yellow < 50-75%)

*Deliverable II: HSCDELF Ages 3-5yrs to WA-ELG Ages 4-5yrs / Deliverable III: HSCDELF Ages 3-5yrs to WA-ELG Ages 5-6yrs*

- Question and Reflect is aligned (Green < 25-50%)
- Describe and Predict are somewhat aligned (Yellow < 50-75%)
- Observe, Compare, Experiment and Cooperate are misaligned ((Red ≤ 75-100%)
- Overall, somewhat aligned (Yellow < 50-75%)

These results are important because they describe young learners' experiences with science benchmarks. Examining data from younger to older age groups of WA-ELG in comparison to HSCDELF data shows alignment decreases. The trend suggests WA-ELG guidelines best prepare young learners across science benchmarks, overall being somewhat aligned. Figures 1-3 show WA-ELG has greater representation of science benchmarks in comparison to HSCDELF (see Tables 1a-3a and Tables 1b-3b). This implies HSCDELF should attend to designing more experiences for young learners to engage in science benchmarks.

*Deliverable IV: HSCDELF Ages 3-5yrs to NGSS Ages 5-6yrs*

- Question is aligned (Green < 25-50%)
- Observe, Predict, and Reflect are somewhat aligned (Yellow < 50-75%)
- Describe, Compare, Experiment and Cooperate are misaligned (Red ≤ 75-100%)

- Overall, somewhat aligned (Yellow < 50-75%)

*Deliverable V: WA-ELG Ages 3-4yrs to NGSS Ages 5-6yrs*

- Observe and Experiment are best aligned (Blue ≥ 0-25%)
- Compare, Question and Predict are aligned (Green < 25-50%)
- Describe, Reflect, and Cooperate are misaligned (Red ≤ 75-100%)
- Overall, aligned (Green < 25-50%)

*Deliverable VI: WA-ELG Ages 4-5yrs to NGSS Ages 5-6yrs*

- Observe, Compare, Question, Predict, Experiment are best aligned (Blue ≥ 0-25%)
- Describe is aligned (Green < 25-50%)
- Reflect is somewhat aligned (Yellow < 50-75%)
- Cooperate is misaligned (Red ≤ 75-100%)
- Overall, best aligned (Blue ≥ 0-25%)

*Deliverable VII: WA-ELG Ages 5-6yrs to NGSS Ages 5-6yrs*

- Observe, Compare, Question, Predict, Experiment are best aligned (Blue ≥ 0-25%)
- Describe and Reflect are aligned (Green < 25-50%)
- Cooperate is misaligned (Red ≤ 75-100%)
- Overall, best aligned (Blue ≥ 0-25%)

These results are important because they describe how WA-ELG and HSCDELF prepare young learners for NGSS expectations, across science benchmarks. Comparing WA-ELG to HSCDELF, data suggests that WA-ELG indicators best prepare young learners. Deliverable IV describes findings for HSCDELF as not aligned. For WA-ELG, younger to older age groups, Deliverables V-VII shows an increase of alignment, from aligned to best aligned. This suggests that WA-ELG indicators are best aligned to meet NGSS kindergarten expectations.

Overall, alignment or match as described in Deliverables I-VII are important because each standard serves varying communities, as shown in Table 2. ECE programs can be federally or state granted, or a combination of the two. This creates various pathways for young learners to experience science. While standards can differ in theoretical underpinnings, alignment measures the scale of science experience designed by each standard.

*Vertical Analysis: Balance of WA-ELG*

*Deliverable VIII: WA-ELG Science Benchmarks Developmental Progression across Age Cohorts*

The objective of balance analysis of WA-ELG is to evaluate the level of developmental progression of science benchmarks, from birth through age six. The purpose of balance is to examine the level of linear progression and identify inconsistencies to inform changes. Updates should be geared to best prepare young learners for kindergarten success. Figures 8a-8d show balance of age cohorts of each individual science benchmark and an overall (for age cohort). Figures 8a-8d also shows the emphasis of the document, as a whole, on each science benchmark. Figure 8e shows the linear regression line and coefficient of determination for each science benchmark. Since the scope of this analysis was limited, birth through age six, such balance analysis was examined for WA-ELG as it focused on multiple age cohorts, not for HSCDELF and NGSS.

For WA-ELG, across age cohorts, science benchmarks each suggest a different focus, for each science benchmark and WA-ELG as a whole (see Figures 8a-8d). The critical findings are:

- Observe: suggest a linear progression, birth through age six.
- Describe: suggests a non-linear progression, with no counts for age cohorts: B-11 mo, 9-18 mo, and 3-4 yrs.
- Compare: suggest a linear progression, birth through age six.

- Question: suggest a linear progression, from age cohort 3-4 yrs to 5-6 yrs, with no counts for age cohort: B-11 mo.
- Predict: suggests a linear progression, from age cohort: 16-36 mo, 4-5 yrs and 5-6 yrs, with no counts for younger age cohorts and 3-4 yrs.
- Experiment: suggests a linear progression, birth through age six.
- Reflect: suggests a linear progression, age cohort 3-4 yrs to 5-6 yrs, with no counts for younger age groups.
- Cooperate: suggest no counts, birth though age six.
- Overall: suggests a linear progression in experiences, birth through age six.

Figure 8e shows the linear correlation and coefficient of determination for each science benchmark. The slopes show the increase of counts per unit and the coefficient of determination shows how well data fits a linear progression.

To conclude, while overall counts for WA-ELG suggest a linear growth, when examining individual science benchmarks, contradictions are identified. Contradictions or not-counts are gaps or places to direct changes within science benchmarks and across age cohorts. Some critical findings, as shown in Figures 8a-8d, are:

- Cooperate has no counts, throughout age cohorts
- Toddlers, age 16-36 mo, practice prediction while age 3-4 yr olds show no counts
- Preschool age groups' experiences across science benchmarks are best attended to in comparison to infants and toddlers, which show minimal to no counts across science benchmarks

Findings suggest that the level of cognitive development or sense making skills do not incorporate group work. Much like scientists, cultural groups make meaning of the world around them in teamwork settings. Singing, talking, and reading is teaching and learning. Science benchmarks can introduced to young learners in developmentally appropriate ways. For example, Cooperate can be taught in individual, small or whole group discourse. The language young learners hear is teaching and learning. Teachers take the lead in discourse and become more flexible with age and ability of young learners. Eliciting sense making skills with open ended questions and providing hints advances the acquisition of knowledge for young learners.

*Vertical Analysis: Balance of Standards (Preschool to Kindergarten)*

*Deliverable IX: WA-ELG, HSCDELF, and NGSS Science Benchmarks Counts by Age Cohorts*

The objective of balance analysis of WA-ELG and HSCDEFL in comparison to NGSS is to examine how standards prepare young learners for NGSS expectations, preschool to kindergarten. The purpose is to identify science benchmarks that are absent that should be considered for inclusion. Figure 8a shows standards' focus of science benchmarks across age groups. Figures 8b and 8d show the counts for each science benchmark by age group, across standards.

Table 9b and Figure 9bshow important findings, when HSCDELF 3-5 yrs and WA-ELG 5-6 yrs are compared to NGSS:

- HSCDELF (Ages 3-5 yrs)
    - Observe, Describe, Compare, Predict, Experiment, Reflect, Cooperate do not meet expectations (Red ≥ 0-25%)
    - Question somewhat meets expectations (Yellow < 25-50%)
    - Overall, does not meet expectations (Red ≥ 0-25%)
- WA-ELG (Ages 3-4 yrs)
    - Observe and Experiment exceed expectations (Blue ≤ 75-100%)

    - Compare, Question and Predict somewhat meet expectations (Yellow < 25-50%)
    - Describe, Reflect, and Cooperate do not meet expectations (Red ≥ 0-25%)
    - Overall, somewhat meets expectations (Yellow < 25-50%)
- WA-ELG (Ages 4-5 yrs)
    - Observe, Question, Predict, and Experiment exceed expectations (Blue ≤ 75-100%)
    - Compare meets expectations (Green < 50-75%)
    - Describe somewhat meets expectations (Yellow < 25-50%)
    - Reflect and Cooperate do not meet expectations (Red ≥ 0-25%)
    - Overall, meets expectations (Green < 50-75%)
- WA-ELG (Ages 5-6 yrs)
    - Observe, Question, Predict and Experiment exceed expectations (Blue ≤ 75-100%)
    - Describe and Compare meets expectations (Green < 50-75%)
    - Reflect somewhat meets expectations (Yellow < 25-50%)
    - Cooperate does not meet expectations (Red ≥ 0-25%)
    - Overall, meets expectations (Green < 50-75%)

To conclude, it is important to evaluate the extent to which HSCDELF and WA-ELG prepare young learners for kindergarten science expectations, or NGSS. Science benchmarks that should be included, for each standard, are color coded in range of need: Blue ≤ 75-100%, Green < 50-75%, Yellow < 25-50%, and Red ≥ 0-25%. The color scheme represents: exceeds expectations (Blue), meets expectations (Green), somewhat meets expectations (Yellow), does not meet expectations (Red). The main findings described above are shown in Table 9b and Figure 9b.

## Limitations

In this section, I would like to address the limitations of my study: 1) perspective 2) timing and 3) science through literacy, identity and culture. First, this study is limited through my own perspective as there were no multiple coders evaluating documents. Results suggest some findings and possible implications; however, strength in coders would reify findings.

Next, the limitation of time. Initially, the planned outcome was to conduct a systems level analysis of standards, curriculums and their assessments to describe a holistic examination of a young learner's experiences. The analysis phase was meant as a multi-dimensional stepwise function. However, because of timing, this goal was modified to analyze standards and leave curriculums and their assessments as next steps. The objective was to determine if there is both match and quality. Match addresses alignment while quality measures whether there is an increase in cognitive development. It is important to label that though documents can be well aligned, or match, documents may or may not cover essential areas of learning and development (Kagan et al., 2013). In this study, only match or alignment was examined.

Lastly, I was not able to address how science can be taught through literacy and the importance of identity and culture. Understanding how identity and culture influence learning and who sees oneself as scientists can be a building block for guidelines. Theoretical underpinnings of standards and curriculums that address culture and identity are an important function for young learners (National Research Council, 2014). Such absence can narrow who is seen as a scientist and who gets to participate in generating ideas.

## Conclusions

Young learners can learn about the world much like scientists do (Gopnik, 2010). Standards should provide ongoing professional development for teachers to feel better prepared to design meaningful science experiences. Expansive learning in professional development can bridge classification systems to model how scientists use categories and facts to make sense of the world around them.

State standards should include strategies and suggestions to facilitate understanding for parents and providers. Bringing back Gopnik's (2010) research as a marker, curiosity for science and sense making skills are being taught as early as age three. There is a need to advance the discussion of what sense making skills look like and how the practice should look. Eberback and Crowley (2009) reify this movement in an attempt to discuss how science practices, for example observation, are hard to teach and learn. It is not intuitive knowing what to look for when engaging in science practices, especially for young learners. Leander *et al*.'s (2010) framework positions science practices themselves as not the concern, whereas how learners learn to develop and use such practices is the issue – the cap to the container.

Scientists use classification systems to make sense of the world around them while young learners learn science as a set of categories or facts. The way young learners are asked to engage in sense making skills about the world caps knowledge, leading to normativity (Leander *et al.*, 2010). As a teacher, you don't have to know all the answers, but you do need to know the questions. Children are more competent in math and science than teachers and parents realize.

When analyzing how teachers learn and teach it is important to keep in mind that children do not just "acquire language." They always acquire a particular type of language, or speech genre (Bakhtin, 1986), appropriate to each social setting. All the spheres even before we come on the scene are maintained in existence by an ongoing communicative process of a particular kind. Such reinforcement is what gives them their particular character as the spheres they are.

Bakhtin's schema posits that each individual brings forth their own "prior knowledge" (Bransford *et al.,* 2000) or "sets of speech genres" from which to make sense of the world around them. To this point, Ojalehto and Medin (2015) posit, "concepts are the 'units of thought' that form the building blocks of domain specific to folk theories... culture can be seen as 'input' to domain-specific cognitive systems that structure learning." In other words, culture is a mediator that permeates thought to structure and gives meaning to utterances, "voices."

Bransford *et al.* (2000) extends current understanding of the struggles faced by people of color: "school failure may be partly explained by the mismatch between what students have learned in their home cultures and what is required of them in school... Every day family habits and rituals can either be reinforced or ignored in schools, and they can produce different response from teachers." Vygotsky saw that understanding human behavior required a historical perspective that engaged analysis at all scales: from the individual to the societal to the level of the species (Cole, 2005). Lee (2002) extends reasons why failure is present for individuals; the author suggests that a movement away from broad race-based categorization and towards studying cultural communities and the variations allowed within them would be a better means of describing human development. Individual variability is much greater than inter-group variability. The article leads one to question how to understand diversity in a way that fully captures the complexity of every individual's simultaneous membership in several cultural communities.

Similarly, Nasir *et al.* (2006) explore the structures of a learning environment that would be adaptive and appropriate for individuals with varied "repertoires of practice." The authors discuss how learners unfamiliar with academic disciplinary practices but familiar with other methods of learning are unaware of their capabilities in formal learning environments because of how knowledge and skills are represented to them, i.e., context dependent performance. Bakhtin's (1986) system of discourse theorizes that formal settings expect children of color to undertake and be assessed by the dominant groups' speech sphere, which has a distinct composition: "style," "finalization," and "relation of utterance to speaker and audience" from that of their home culture. Formal settings failing to acknowledge different paradigms of speech spheres make it difficult for diverse groups to succeed.

Adichie (2009) captures the dangers of single speech genres; she tells the danger of the single story and warns if we only hear a single story of a person or country, we risk a critical misunderstanding. The story she tells is about finding her authentic critical voice through navigating among and across "speech genres" (Bakhtin, 1986). Bringing back early childhood education and the interwoven relationship to STEM, more research efforts and investments focused on core issues of diversity and equity attending to the interwoven relation of language and STEM can result in manifold benefits for childhood outcomes.

Guidelines pave way for expansive learning, designing pathways. Each guideline sets forth its own conceptual framework and theoretical underpinning. Some communication or level of alignment can lead to design of successive steps for success. This requires that standards not only be balanced at a group level, but at individual compartments as well. This line of thinking creates places for other voices to be heard and to resonate in the ongoing conversation on how to design meaningful learning places for all young learners.

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**Tables and Figures**

Table 1. Science Benchmarks and Definitions

| Benchmark | Definition |
|---|---|
| Observing | Using the five senses and appropriate tools to explore and learn about the surrounding world |
| Describing | Providing verbal or pictorial representations of things or events |
| Comparing | Examining things or events in order to note similarities and/or differences |
| Questioning | Expressing inquiry/doubts that call for a reply/response |
| Predicting | Foretelling events or noting patterns of events, based on knowledge or inference |
| Experimenting | Trying an action or activity to discover an unknown result or answer |
| Reflecting | Thinking about/pondering new information and incorporating it into a knowledge base |
| Cooperating | Working as a group to collect information and sharing findings with others |

*Note: STEM benchmarks and definitions adopted from Greenfield *et al.* (2010)

Table 2. HSCDELF, WA-ELG and NGSS Age and Standard Alignment

| | B-11 mo | 9-18 mo | 16-36 mo | 3-4 yrs | 4-5 yrs | 5-6 yrs |
|---|---|---|---|---|---|---|
| HSCDELF | | | | Migrant Head Start<br>Tribal Head Start<br>(American Indian-Alaska Native Program Branch) | | |
| WA-ELG | Early Head Start<br>State Early Learning Plan<br>Tribal Learning Standards | | | Migrant Head Start<br>Tribal Head Start<br>(American Indian-Alaska Native Program Branch)<br>ECEAP<br>State Early Learning Plan<br>Tribal Learning Standards | | State Early Learning Plan<br>Tribal Learning Standards<br>Common Core |
| NGSS | | | | | | Common Core |

Table 3. Washington State Early Learning and Development Guidelines Ages B-11 Months

| *Learning about my world* | *WA-ELG* | |
|---|---|---|
| ***>Knowledge (cognition)*** | Uses the senses (mouthing, watching, grasping, reaching) to get information and explore what is nearby. | O |
| | Use more than one sense at a time, such as when looking at, feeling and shaking a rattle. | O/C |
| | Repeat behaviors to figure out cause and effect. For example, a toy released high always goes down (law of gravity). | E |
| | Enjoy filling containers and dumping them out. | O |

| | | |
|---|---|---|
| | Show interest in animals and pictures of animals. | O |
| **> Science** | Pay attention to sights and sounds. | O |
| | Look for dropped objects. | O |
| | Gaze at and track an object with his/her eyes. | O |
| | Act to trigger a pleasing sight, sound or motion, such as kicking at a mobile; repeat actions many times to cause a desired effect. | E |
| | Show curiosity about things and try to get things that are out of reach. | O |
| | Imitate sounds, imitate actions, such as clapping hands, pushing a toy. | O |
| | Search for a hidden object. | O |

Key: O=observe, D=describe, C=compare, Q=question, P=predict, E=experiment, R=reflect, and Co=cooperate.

Table 3a. Counts for Washington State Early Learning and Development Guidelines Ages B-11 Months

| Science Construct | Knowledge (cognition) | Science |
|---|---|---|
| Observe | 4 | 6 |
| Describe | 0 | 0 |
| Compare | 1 | 0 |
| Question | 0 | 0 |
| Predict | 0 | 0 |
| Experiment | 1 | 1 |
| Reflect | 0 | 0 |
| Cooperate | 0 | 0 |

Table 4. Washington State Early Learning and Development Guidelines Ages 9-18 Months

| *Learning about my world* | *WA-ELG* | |
|---|---|---|
| ***>Knowledge(cognition)*** | Observe other's activities. Then imitate their actions, gestures and sounds. | O |
| | Uses imitation to make a desired effect, such as activating a toy, or obtaining an object. | E |
| | Explore things in many ways, such as shaking, banging, poking, and throwing. | O |
| | Enjoy playing hiding games; locate an object that has been hidden from view. | O |
| | Use objects as intended, such as pushing buttons on a toy phone, or drinking from a cup. | O |

| | | |
|---|---|---|
| | Use objects as means to an end, such as using a bucket to take toys from one place to another. | O |
| | Seek caregiver's help by making sounds, words, facial expressions or gestures to obtain an object or start an activity. | Q |
| | Match similar objects. | C |
| | Begin make-believe play and imitate the actions of others, such as rocking and feeding a baby doll | O |
| | Explore objects in nonconventional ways. | O |
| > **Science** | Take action to achieve a goal, such as fitting puzzle pieces together, or activating a toy. | O |
| | Express surprise and delight to play outdoors and with natural elements, such as water, sand and mud. | O |
| | Notice the characteristics of natural things, such as leaves, or events, such as rain or wind. | C |
| | Respond to caregiver's guidance on how to act appropriately toward and around living things. | O |
| | Enjoy using or playing with technology objects, such as a wind-up toy. | O |

Note: O=observe, D=describe, C=compare, Q=question, P=predict, E=experiment, R=reflect, and Co=cooperate.

Table 4a. Counts for Washington State Early Learning and Development Guidelines Ages 9-18 Months

| Science Construct | Knowledge (cognition) | Science |
|---|---|---|
| Observe | 7 | 4 |
| Describe | 0 | 0 |
| Compare | 0 | 1 |
| Question | 1 | 0 |
| Predict | 0 | 0 |
| Experiment | 1 | 0 |
| Reflect | 0 | 0 |
| Cooperate | 0 | 0 |

Table 5. Washington State Early Learning and Development Guidelines Ages 16-36 Months

| *Learning about my world* | *WA-ELG* | |
|---|---|---|
| **> Knowledge (cognition)** | Experiment with the effect of own actions on things and people. | E |
| | Know that playing with certain desirable or forbidden things will get adults' attention. | Q |
| | Make choices, such as which toy to play with. | O |
| | Take action based on past experience. For example, if the caregiver blows on hot food before eating it, child will blow on food at the next meal. | E |
| | Repeat an action over and over until successful, such as stacking blocks until they no longer fall down. | E |
| | Explore and use trial and error to solve problems. | E/O |
| | Imitate how others solve problems. | O |
| | Ask for help when needed. | Q |
| | Show recall of people and events, such as by clapping hands when told that a favorite person will visit. | O |
| | Recall and follow the order of routines, such as washing and drying hands before eating. | O |
| | Play make-believe with props, such as dolls or stuffed animals. | O |
| | React to puppets as if they are real and not operated by an adult or another child. | O |
| **> Science** | Look at and handle things to identify what is the same and what is different about them. | C |
| | Explore nature using the senses, such as looking at and feeling different leaves. | O |
| | Ask simple questions about the natural world ("Where did the rainbow go?"). | Q |
| | Enact animals' activities (such as sleeping) in pretend play.  Move toy animals to mimic animals in the wild. | D |
| | Engage with plants and animals in a respectful way, without adult prompting. Express concern if an animal is injured or sick. Comment on what it takes to make things grow ("That plant needs water"). | D |
| | Identify weather, such as sun, rain, snow. | D |

| | | |
|---|---|---|
| | Know that people and animals can live in different kinds of places, such as fish living in the water. | O |

Note: O=observe, D=describe, C=compare, Q=question, P=predict, E=experiment, R=reflect, and Co=cooperate.

Table 5a. Counts for Washington State Early Learning and Development Guidelines Ages 16-36 Months

| Science Construct | Knowledge (cognition) | Science |
|---|---|---|
| Observe | 7 | 2 |
| Describe | 0 | 3 |
| Compare | 0 | 1 |
| Question | 2 | 1 |
| Predict | 0 | 0 |
| Experiment | 4 | 0 |
| Reflect | 0 | 0 |
| Cooperate | 0 | 0 |

Table 6. Washington State Early Learning and Development Guidelines Ages 3-4 Years

| *Learning about my world* | *WA-ELG* | |
|---|---|---|
| > **Knowledge (cognition)** | Ask a lot of "why" and "what" questions. | R |
| | Learn by doing hands-on and through the senses. | O |
| | Learn through play. | O |
| | Recall several items after they have been put out of sight. | O |
| | Draw on own past experiences to choose current actions. | P |
| | Make plans for ways to do something. May or may not follow through. | P |
| | Think of a different way to do something, when confronting a problem, with adult help. | E |
| > **Science** | Play with materials of different textures (such as sand, water, leaves) and conditions (such as wet, dry, warm, cold), with adult encouragement and supervision. | O |
| | Recognize that different forms of life have different needs. | R |
| | Begin to understand that some animals share similar characteristics (for example, a tiger and a pet cat share common features). | C |

| | | |
|---|---|---|
| | Notice and ask questions about what is the same and different between categories of plants and animals. | O/C/Q |
| | Notice their appearance, behavior and habitat. | O |

Note: O=observe, D=describe, C=compare, Q=question, P=predict, E=experiment, R=reflect, and Co=cooperate.

Table 6a. Counts for Washington State Early Learning and Development Guidelines Ages 3-4 Years

| Science Construct | Knowledge (cognition) | Science |
|---|---|---|
| Observe | 3 | 3 |
| Describe | 0 | 0 |
| Compare | 0 | 2 |
| Question | 0 | 1 |
| Predict | 2 | 0 |
| Experiment | 1 | 0 |
| Reflect | 1 | 1 |
| Cooperate | 0 | 0 |

Table 7. Washington State Early Learning and Development Guidelines Ages 4-5 years

| *Learning about my world* | *WA-ELG* | |
|---|---|---|
| > **Knowledge (cognition)** | Ask adults questions to get information (as appropriate in the family's culture). | Q |
| | Describe likes and interests. | D |
| | Apply new information or words to an activity or interaction. | E |
| | Build on and adapt to what the child learned before. For example, change the way of stacking blocks after a tower continues to fall. | D |
| | Be able to explain what he or she had done and why, including any changes made to his/her plans. | E |
| | Seek to understand cause and effect ("If I do this, why does that happen?"). | C |
| | Understand the ideas of "same" and "different." | O |
| | Recognize objects, places and ideas by symbols (for example, recognize which is the men's room and which is the women's by looking at the stick figure symbols). | D |
| | Name more than three colors. | D |
| | Group some everyday objects that go together (such as shoe and sock, pencil and paper). | C |

| | | |
|---|---|---|
| | Predict what comes next in the day when there is a consistent schedule. | P |
| **> Science** | Ask questions and identify ways to find answers. Try out these activities and think about what to do next to learn more. | Q/E |
| | Predict what will happen in science and nature experiences. Consider whether these predictions were right, and explain why or why not. | P/R |
| | Use tools to explore the environment (a magnifying glass, magnets, sifters, etc). | E |
| | Measure sand or water using a variety of containers.<br>Use one sense (such as smell) to experience something and make one or two comments to describe this. | O/D |
| | Investigate the properties of things in nature. Begin to understand what various life forms need in order to grow and live. | R/Q |
| | Take responsibility in taking care of living things, such as feeding the fish, watering plants, etc. | O |
| | Talk about changes in the weather and seasons, using common words, such as rainy and windy. | D |
| | Look at where the sun is in the morning, afternoon, evening, and night. | C |
| | Take walks outside and gather different types of leaves, name colors he/she sees outdoors. | D/C |
| | Participate (with adult direction) in activities to preserve the environment, such as disposing of litter properly, saving paper and cans to be recycled, etc. | Q |

Note: O=observe, D=describe, C=compare, Q=question, P=predict, E=experiment, R=reflect, and Co=cooperate.

Table 7a. Counts for Washington State Early Learning and Development Guidelines Ages 4-5 Years

| Science Construct | Knowledge (cognition) | Science |
|---|---|---|
| Observe | 0 | 2 |
| Describe | 4 | 3 |
| Compare | 1 | 2 |
| Question | 1 | 3 |
| Predict | 1 | 1 |
| Experiment | 2 | 2 |

| | | |
|---|---|---|
| Reflect | 0 | 2 |
| Cooperate | 0 | 0 |

Table 9. Washington State Early Learning and Development Guidelines Ages 5-6 Years

| *Learning about my world* | *WA-ELG* | |
|---|---|---|
| > **Knowledge (cognition)** | Learn best through active exploration of concrete materials (blocks, paint, etc.). Make plans for this exploration. Talk about what he/she has learned from the activity and would like to do next. | O/E/D |
| | Understand that things are not always what they appear to be (for example, a sponge may look like a rock). | R |
| | Explore different environments inside and outside. | O |
| > **Science** | Make observations and ask questions. Identify ways to find answers. Try out these activities and think about what to do next to learn more. | O/Q/P/R |
| | Recognize landmarks in the local environment (lakes, rivers, rock formation, etc.). | O |
| | Name many of the basic needs of animals and people (habitat). | O |
| | Identify what different animals eat. Begin to understand that some animals eat other animals, and some eat plants. | O/R |
| | Begin to understand how the things people do may change the environment. Recognize that the child's own actions have an effect on the environment for the better (such as watering plants) or worse (such as stomping on plants). | R/E |
| | Begin to tell the difference between materials that are natural and those made by humans. | C |

Note: O=observe, D=describe, C=compare, Q=question, P=predict, E=experiment, R=reflect, and Co=cooperate.

Table 9a. Counts for Washington State Early Learning and Development Guidelines Ages 5-6 years

| Science Construct | Knowledge (cognition) | Science |
|---|---|---|
| Observe | 2 | 4 |
| Describe | 1 | 0 |
| Compare | 0 | 1 |
| Question | 0 | 1 |
| Predict | 0 | 1 |
| Experiment | 1 | 1 |

| | | |
|---|---|---|
| Reflect | 1 | 3 |
| Cooperate | 0 | 0 |

Table 9. The Head Start Child Development and Early Learning Framework Ages 3-5 Years

| *DOMAIN: SCIENCE KNOWLEDGE & SKILLS* | *HSCDELG* | |
|---|---|---|
| > **Domain Element: Scientific Skills & Method –** *The skills to observe and collect information and use them to ask questions, predict, explain and draw conclusions.* | Model curiosity, inquiry, and investigation for children. | O |
| | Listen to children and ask about what they are seeing and doing. When children talk with interested adults about what they see, hear, and think, they do more noticing, wondering, and reflecting. | O/Q/R |
| | Incorporate science projects and skills as children play with blocks, water, sand, playdough, and other materials, and as they engage in dramatic play, cooking, art, music and movement, stories, and outdoor experiences. | O |
| | Encourage children's natural inclination to ask questions and to wonder. | Q |
| | Engage children in science and math experiences that start with asking questions, forming hypotheses or making guesses, collecting data, and drawing conclusions. | D/Q/E/P/R |
| | Build on and extend children's interest in the physical world and living things by using information, books, field trips, visitors, and other ways of opening the classroom to science. | O |
| | Give children journals, clipboards, and writing tools to engage them in recording observations, gathering data, and communicating their findings to others. | D/Co |
| > **Domain Element: Conceptual Knowledge of the Natural and Physical World –** *The acquisition of concepts and facts related to the natural and physical world and the understanding of naturally occurring relationships.* | Plan in-depth projects or topics of study related to science knowledge that build on and expand children's interests. | R |
| | Incorporate science projects and skills as children play with blocks, water, sand, playdough, and other materials, and as they engage in dramatic play, cooking, art, music and movement, stories, and outdoor experiences. | O |

| | | |
|---|---|---|
| | Engage children in coherent studies of animals, plants, and the environment. | C |
| | Model an attitude of openness and flexibility to asking questions, not needing to have all the answers. | Q |

Note: O=observe, D=describe, C=compare, Q=question, P=predict, E=experiment, R=reflect, and Co=cooperate.

Table 9a. Counts for The Head Start Child Development and Early Learning Framework Ages 3-5 Years

| Science Construct | Domain Element: Scientific Skills and Methods | Domain Element: Conceptual Knowledge of the Natural and Physical World |
|---|---|---|
| Observe | 4 | 1 |
| Describe | 2 | 0 |
| Compare | 0 | 1 |
| Question | 3 | 1 |
| Predict | 1 | 0 |
| Experiment | 1 | 0 |
| Reflect | 2 | 1 |
| Cooperate | 1 | 0 |

Table 10. NGSS: Forces and Interactions: Pushes and Pulls Ages 5-6 Years

| *Kindergarten Forces and Interactions: Pushes and Pulls* | *NGSS* | |
|---|---|---|
| **> Science and Engineering Practices** | **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>With guidance, plan and conduct an investigation in collaboration with peers. (K-PS2-1) | E/R/Q/P/Co |
| | **Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>Analyze data from tests of an object or tool to determine if it works as intended. (K-PS2-2) | R/D/C |

| | | |
|---|---|---|
| | **Scientific Investigations Use a Variety of Methods**<br>Scientists use different ways to study the world. (K-PS2-1) | O |
| **> Disciplinary Core Ideas** | **PS2.A: Forces and Motion**<br>Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2)<br>Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2) | O/C |
| | **PS2.B: Types of Interactions**<br>When objects touch or collide, they push on one another and can change motion. (K-PS2-1) | O |
| | **PS3.C: Relationship Between Energy and Forces**<br>A bigger push or pull makes things speed up or slow down more quickly. *(secondary to K-PS2-1)* | O |
| | **ETS1.A: Defining Engineering Problems**<br>A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. *(secondary to K-PS2-2)* | D/Q |
| ***> Cause and Effect*** | **Cause and Effect**<br>Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS2-1), (K-PS2-2) | O/E |

Table 10a. Counts for NGSS: Forces and Interactions: Pushes and Pulls Ages 5-6 Years

| Science Construct | Science and Engineering Practices | Disciplinary Core Areas | Crosscutting Concepts |
|---|---|---|---|
| Observe | 1 | 3 | 1 |
| Describe | 1 | 1 | 0 |
| Compare | 1 | 1 | 0 |
| Question | 1 | 1 | 0 |
| Predict | 1 | 0 | 0 |
| Experiment | 1 | 0 | 1 |
| Reflect | 2 | 0 | 0 |
| Cooperate | 1 | 0 | 0 |

Table 11. NGSS: Interdependent Relationships in Ecosystems: Animals, Plants and Their Environments Ages 5-6 Years

| *Kindergarten Interdependent Relationships in Ecosystems: Animals, Plants and Their Environments* | *NGSS* | |
|---|---|---|
| **> Science and Engineering Practices** | **Developing and Using Models**<br>Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions.<br>Use a model to represent relationships in the natural world. (K-ESS3-1) | D/R |
| | **Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>Use observations (firsthand or from media) to describe patterns in the natural world to answer scientific questions. (K-LS1-1) | C/R/ D/O/ Co |
| | **Engaging in Argument from Evidence**<br>Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).<br>Construct an argument with evidence to support a claim. (K-ESS2-2) | R/D/ C/Co |
| | **Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.<br>Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (K-ESS3-3) | O/C/ R/Co |
| | **Scientific Knowledge is Based on Empirical Evidence**<br>Scientists look for patterns and order | O |

| | | |
|---|---|---|
| | when making observations about the world. (K-LS1-1) | |
| > **Disciplinary Core Ideas** | **LS1.C: Organization for Matter and Energy Flow in Organisms**<br>All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. (K-LS1-1) | O |
| | **ESS2.E: Biology**<br>Plants and animals can change their environment. (K-ESS2-2) | O |
| | **ESS3.A: Natural Resources**<br>Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. (K-ESS3-1) | O |
| | **ESS3.C: Human Impacts on Earth Systems**<br>Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (K-ESS3-3) | O/R |
| | **ETS1.B: Developing Possible Solutions**<br>Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. *(secondary to K-ESS3-3)* | D/Co |
| > ***Cause and Effect*** | **Patterns**<br>Patterns in the natural and human designed world can be observed and used as evidence. (K-LS1-1) | O/D |
| | **Cause and Effect**<br>Events have causes that generate observable patterns. (K-ESS3-3) | O |
| | **Systems and System Models**<br>Systems in the natural and designed world have parts that work together. (K-ESS2-2), (K-ESS3-1) | O |

| Science Construct | Science and Engineering Practices | Disciplinary Core Areas | Crosscutting Concepts |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Observe | 3 | 4 | 3 |
| Describe | 3 | 2 | 0 |
| Compare | 3 | 1 | 0 |
| Question | 0 | 0 | 0 |
| Predict | 0 | 0 | 1 |
| Experiment | 0 | 0 | 0 |
| Reflect | 4 | 1 | 0 |
| Cooperate | 3 | 1 | 0 |

Table 11a. Counts for NGSS: Interdependent Relationships in Ecosystems: Animals, Plants and Their Environments Ages 5-6 years

Table 12. NGSS: Weather and Climate Ages 5-6 Years

| *Kindergarten Weather and Climate* | *NGSS* | |
|---|---|---|
| **> Science and Engineering Practices** | **Asking Questions and Defining Problems**<br>Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.<br>Ask questions based on observations to find more information about the designed world. (K- ESS3-2) | O/Q/ R/D/ E |
| | **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>Make observations (firsthand or from media) to collect data that can be used to make comparisons. (K-PS3-1) | Q/R/ E/O/ D/C |
| | **Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-ESS2-1) | E/R/ O/D/ C/Q/ Co |

| | | |
|---|---|---|
| | **Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.<br>Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem. (K-PS3-2) | D/R/ E/O/P |
| | **Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.<br>Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world. (K-ESS3-2) | O/D/ R/Co |
| | **Scientific Investigations Use a Variety of Methods**<br>Scientists use different ways to study the world. (K-PS3-1) | O |
| | **Science Knowledge is Based on Empirical Evidence**<br>Scientists look for patterns and order when making observations about the world. (K-ESS2-1) | O/C |
| **> Disciplinary Core Ideas** | **PS3.B: Conservation of Energy and Energy Transfer**<br>Sunlight warms Earth's surface. (K-PS3-1),(K-PS3-2) | O |
| | **ESS2.D: Weather and Climate**<br>Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1) | O/D/ R |

| | | |
|---|---|---|
| | **ESS3.B: Natural Hazards**<br>Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that communities can prepare for and respond to these events. (K-ESS3-2) | O |
| | **ETS1.A: Defining and Delimiting an Engineering Problem**<br>Asking questions, making observations, and gathering information are helpful in thinking about problems. *(secondary to K-ESS3-2)* | O/D/Q |
| ***> Cause and Effect*** | **Patterns**<br>Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1) | O/D/E |
| | **Cause and Effect**<br>Events have causes that generate observable patterns. (K-PS3-1), (K-PS3-2), (K-ESS3-2) | O |
| | **Interdependence of Science, Engineering, and Technology**<br>People encounter questions about the natural world every day. (K-ESS3-2) | Q |
| | **Influence of Engineering, Technology, and Science on Society and the Natural World**<br>People depend on various technologies in their lives; human life would be very different without technology. (K-ESS3-2) | O |

Table 12a. Counts for NGSS: Weather and Climate Ages 5-6 Years

| Science Construct | Science and Engineering Practices | Disciplinary Core Areas | Crosscutting Concepts |
|---|---|---|---|
| Observe | 7 | 8 | 3 |
| Describe | 5 | 3 | 1 |
| Compare | 3 | 0 | 1 |
| Question | 3 | 2 | 1 |
| Predict | 1 | 0 | 0 |
| Experiment | 4 | 1 | 0 |
| Reflect | 5 | 1 | 0 |
| Cooperate | 2 | 0 | 0 |

Table 13. NGSS: Engineering Design Ages 5-6 Years

| *Kindergarten Engineering Design* | *NGSS* |
|---|---|

| | | |
|---|---|---|
| **> Science and Engineering Practices** | **Asking Questions and Defining Problems**<br>Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions.<br>Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1)<br>Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) | Q/D/R/O/E |
| | **Developing and Using Models**<br>Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.<br>Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2) | R/D |
| | **Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3) | R/C/D/E/Co |
| **> Disciplinary Core Ideas** | **ETS1.A: Defining and Delimiting Engineering Problems**<br>A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1)<br>Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)<br>Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1) | Q/O/D/R |
| | **ETS1.B: Developing Possible Solutions**<br>Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's | D/Co |

| | | |
|---|---|---|
| | solutions to other people. (K-2-ETS1-2) | |
| | **ESS3.B: Natural Hazards**<br>Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3-2) | Co |
| | **ETS1.C: Optimizing the Design Solution**<br>Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3) | C/E |
| ***> Cause and Effect*** | **Structure and Function**<br>The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2) | C |

Table 13a. Counts for NGSS: Engineering Design Ages 5-6 Years

| Science Construct | Science and Engineering Practices | Disciplinary Core Areas | Crosscutting Concepts |
|---|---|---|---|
| Observe | 1 | 1 | 0 |
| Describe | 3 | 2 | 0 |
| Compare | 1 | 1 | 1 |
| Question | 1 | 1 | 0 |
| Predict | 0 | 1 | 0 |
| Experiment | 2 | 1 | 0 |
| Reflect | 3 | 1 | 0 |
| Cooperate | 1 | 2 | 0 |

Figure 1. Vertical Analysis: Alignment of HSCDELF 3-5 Yrs to WA-ELG 3-4 Yrs

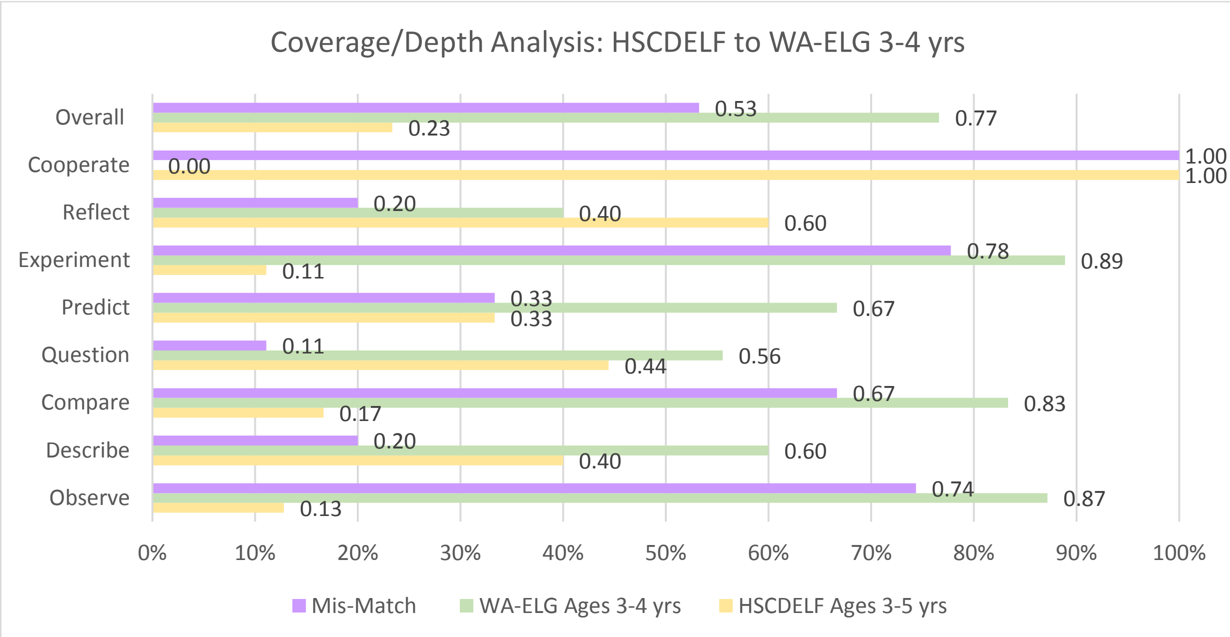



Table 1a. Science Benchmarks Counts to HSCDELF 3-5 Yrs to WA-ELG 3-4 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 5 | 2 | 1 | 4 | 1 | 1 | 3 | 1 | 18 |
| WA-ELG Ages 3-4 yrs | 34 | 3 | 5 | 5 | 2 | 8 | 2 | 0 | 59 |
| Total Counts | 39 | 5 | 6 | 9 | 3 | 9 | 5 | 1 | 77 |

Table 1b. Percentage of Science Benchmark Counts to HSCDELF 3-5 Yrs to WA-ELG 3-4 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 0.13 | 0.40 | 0.17 | 0.44 | 0.33 | 0.11 | 0.60 | 1.00 | 0.23 |
| WA-ELG Ages 3-4 yrs | 0.87 | 0.60 | 0.83 | 0.56 | 0.67 | 0.89 | 0.40 | 0.00 | 0.77 |
| Mis-Match | 0.74 | 0.20 | 0.67 | 0.11 | 0.33 | 0.78 | 0.20 | 1.00 | 0.53 |

Figure 2. Vertical Analysis: Alignment of HSCDELF 3-5 Yrs to WA-ELG 4-5 Yrs

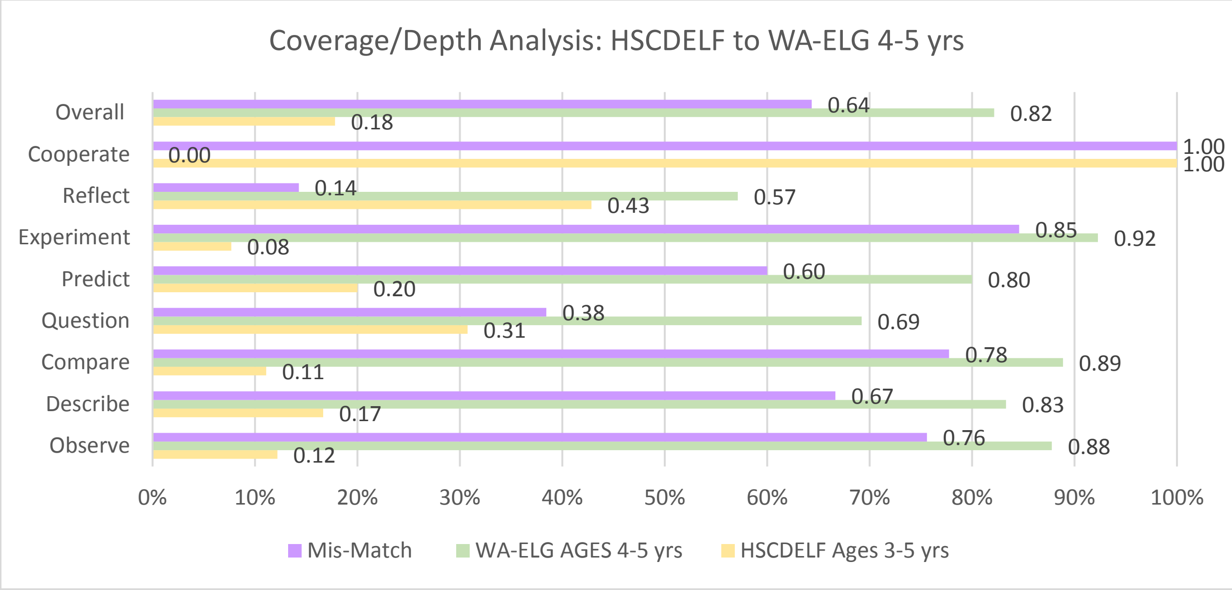



Table 2a. Science Benchmarks Counts to HSCDELF 3-5 Yrs to WA-ELG 4-5 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 5 | 2 | 1 | 4 | 1 | 1 | 3 | 1 | 18 |
| WA-ELG AGES 4-5 yrs | 36 | 10 | 8 | 9 | 4 | 12 | 4 | 0 | 83 |
| Total Counts | 41 | 12 | 9 | 13 | 5 | 13 | 7 | 1 | 101 |

Table 2b. Percentage of Science Benchmark Counts to HSCDELF 3-5 Yrs to WA-ELG 4-5 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 0.12 | 0.17 | 0.11 | 0.31 | 0.20 | 0.08 | 0.43 | 1.00 | 0.18 |
| WA-ELG AGES 4-5 yrs | 0.88 | 0.83 | 0.89 | 0.69 | 0.80 | 0.92 | 0.57 | 0.00 | 0.82 |
| Mis-Match | 0.76 | 0.67 | 0.78 | 0.38 | 0.60 | 0.85 | 0.14 | 1.00 | 0.64 |

Figure 3. Vertical Analysis: Alignment of HSCDELF 3-5 Yrs to WA-ELG 5-6 Yrs

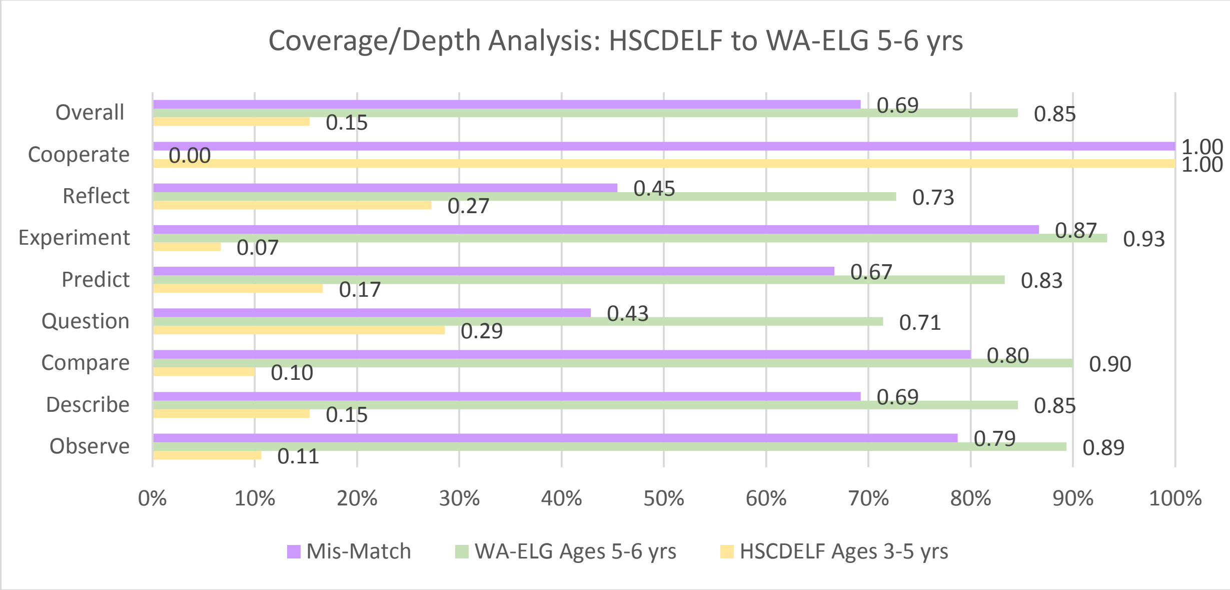



Table 3a. Science Benchmarks Counts to HSCDELF 3-5 Yrs to WA-ELG 5-6 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 5 | 2 | 1 | 4 | 1 | 1 | 3 | 1 | 18 |
| WA-ELG Ages 5-6 yrs | 42 | 11 | 9 | 10 | 5 | 14 | 8 | 0 | 99 |
| Total Counts | 47 | 13 | 10 | 14 | 6 | 15 | 11 | 1 | 117 |

Table 3b. Percentage of Science Benchmark Counts to HSCDELF 3-5 Yrs to WA-ELG 5-6 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 0.11 | 0.15 | 0.10 | 0.29 | 0.17 | 0.07 | 0.27 | 1.00 | 0.15 |
| WA-ELG Ages 5-6 yrs | 0.89 | 0.85 | 0.90 | 0.71 | 0.83 | 0.93 | 0.73 | 0.00 | 0.85 |
| Mis-Match | 0.79 | 0.69 | 0.80 | 0.43 | 0.67 | 0.87 | 0.45 | 1.00 | 0.69 |

Figure 4. Vertical Analysis: Alignment of HSCDELF 3-5 Yrs to NGSS 5-6 Yrs

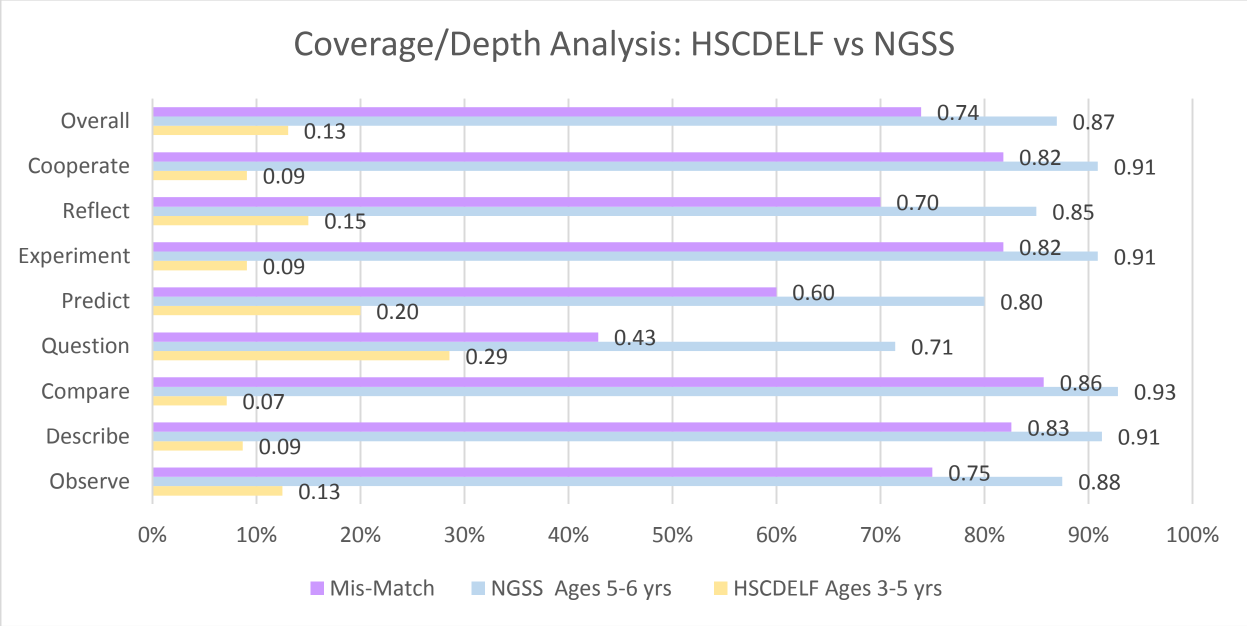



Table 4a. Science Benchmarks Counts to HSCDELF 3-5 Yrs to NGSS 5-6 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 5 | 2 | 1 | 4 | 1 | 1 | 3 | 1 | 18 |
| NGSS Ages 5-6 yrs | 35 | 21 | 13 | 10 | 4 | 10 | 17 | 10 | 120 |
| Total Counts | 40 | 23 | 14 | 14 | 5 | 11 | 20 | 11 | 138 |

Table 4b. Percentage of Science Benchmark Counts to HSCDELF 3-5 Yrs to NGSS 5-6 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 0.13 | 0.09 | 0.07 | 0.29 | 0.20 | 0.09 | 0.15 | 0.09 | 0.13 |
| NGSS Ages 5-6 yrs | 0.88 | 0.91 | 0.93 | 0.71 | 0.80 | 0.91 | 0.85 | 0.91 | 0.87 |
| Mis-Match | 0.75 | 0.83 | 0.86 | 0.43 | 0.60 | 0.82 | 0.70 | 0.82 | 0.74 |

Figure 5. Vertical Analysis: Alignment of WA-ELG 3-4 Yrs to NGSS 5-6 Yrs

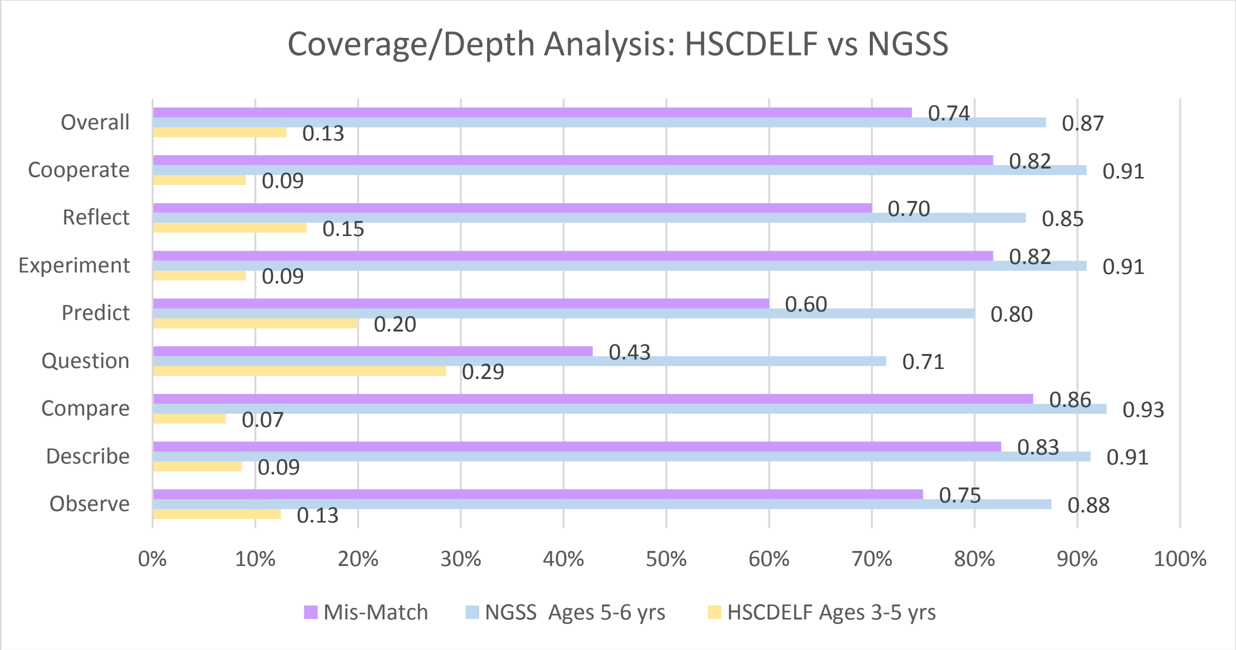



Table 5a. Science Benchmarks Counts to WA-ELG 3-4 Yrs to NGSS 5-6 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| WA-ELG Ages 3-4 yrs | 34 | 3 | 5 | 5 | 2 | 8 | 2 | 0 | 59 |
| NGSS Ages 5-6 yrs | 35 | 21 | 13 | 10 | 4 | 10 | 17 | 10 | 120 |
| Total Counts | 69 | 24 | 18 | 15 | 6 | 18 | 19 | 10 | 179 |

Table 5b. Percentage of Science Benchmark Counts to WA-ELG 3-4 Yrs to NGSS 5-6 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| WA-ELG Ages 3-4 yrs | 0.49 | 0.13 | 0.28 | 0.33 | 0.33 | 0.44 | 0.11 | 0.00 | 0.33 |
| NGSS Ages 5-6 yrs | 0.51 | 0.88 | 0.72 | 0.67 | 0.67 | 0.56 | 0.89 | 1.00 | 0.67 |
| Mis-Match | 0.01 | 0.75 | 0.44 | 0.33 | 0.33 | 0.11 | 0.79 | 1.00 | 0.34 |

Figure 6. Vertical Analysis: Alignment of WA-ELG 4-5 Yrs to NGSS 5-6 Yrs

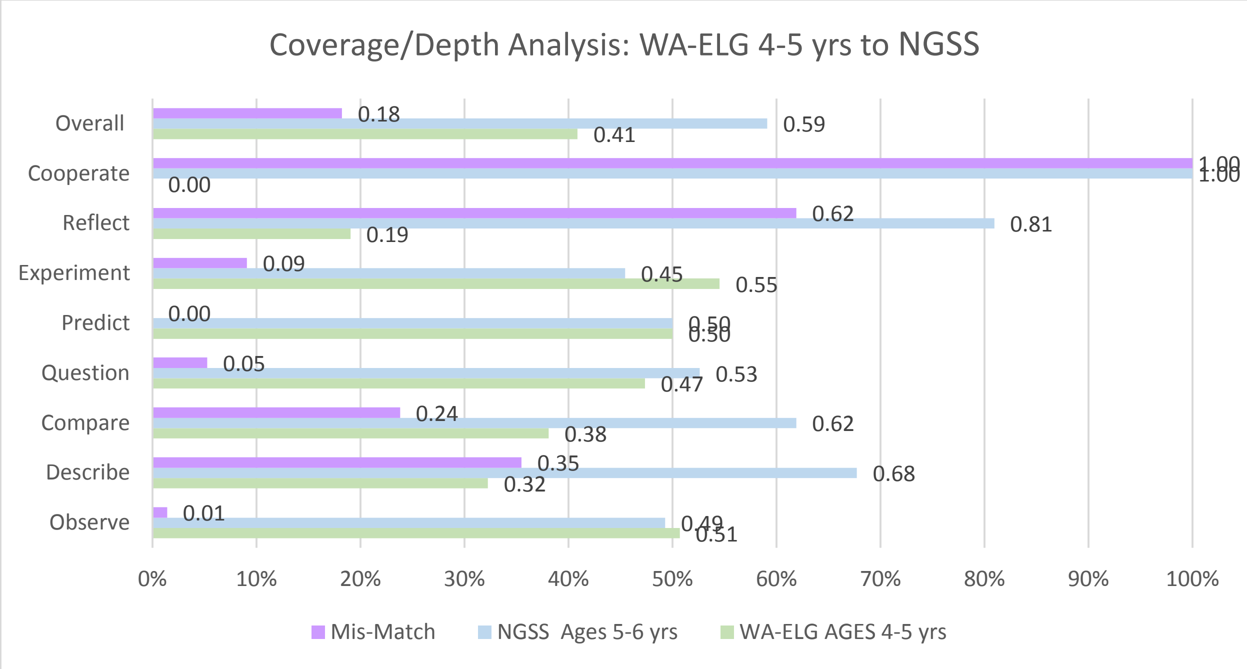



Table 6a. Science Benchmarks Counts to WA-ELG 4-5 yrs to NGSS 5-6 yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| WA-ELG AGES 4-5 yrs | 36 | 10 | 8 | 9 | 4 | 12 | 4 | 0 | 83 |
| NGSS Ages 5-6 yrs | 35 | 21 | 13 | 10 | 4 | 10 | 17 | 10 | 120 |
| Total Counts | 71 | 31 | 21 | 19 | 8 | 22 | 21 | 10 | 203 |

Table 6b. Percentage of Science Benchmark Counts to WA-ELG 4-5 yrs to NGSS 5-6 yrs

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| WA-ELG AGES 4-5 yrs | 0.51 | 0.32 | 0.38 | 0.47 | 0.50 | 0.55 | 0.19 | 0.00 | 0.41 |
| NGSS Ages 5-6 yrs | 0.49 | 0.68 | 0.62 | 0.53 | 0.50 | 0.45 | 0.81 | 1.00 | 0.59 |
| Mis-Match | 0.01 | 0.35 | 0.24 | 0.05 | 0.00 | 0.09 | 0.62 | 1.00 | 0.18 |

Figure 7. Vertical Analysis: Alignment of WA-ELG 5-6 Yrs to NGSS 5-6 Yrs

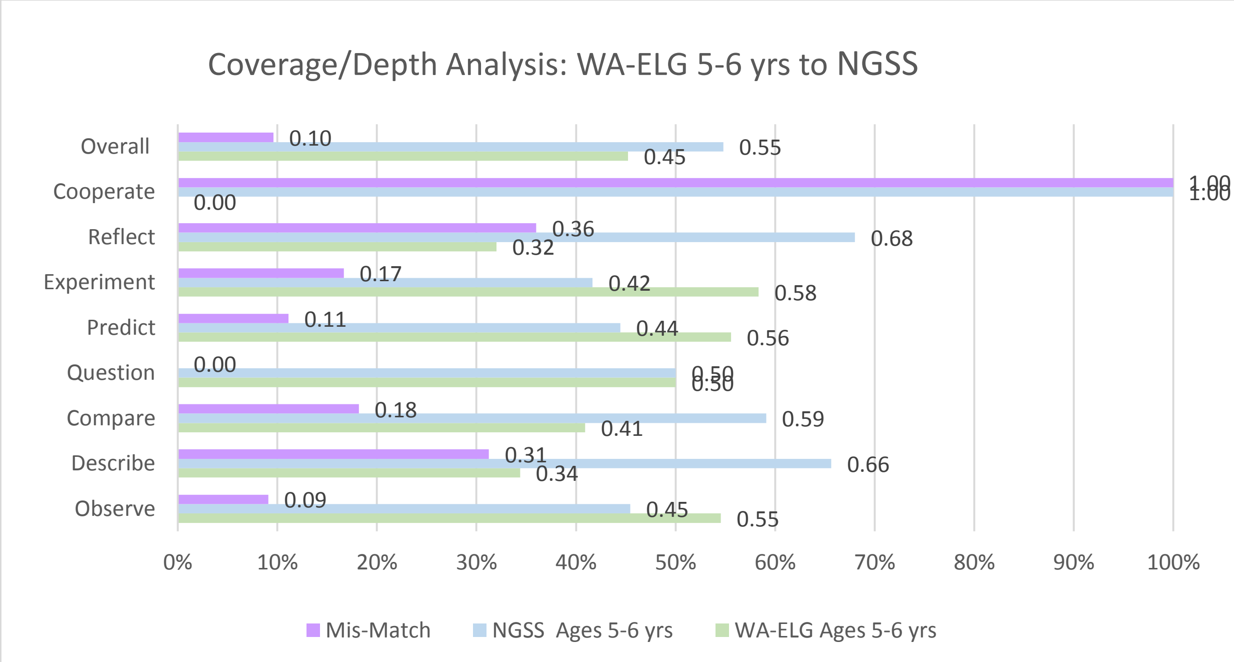



Table 7a. Science Benchmarks Counts to WA-ELG 5-6 Yrs to NGSS 5-6 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| WA-ELG Ages 5-6 yrs | 42 | 11 | 9 | 10 | 5 | 14 | 8 | 0 | 99 |
| NGSS Ages 5-6 yrs | 35 | 21 | 13 | 10 | 4 | 10 | 17 | 10 | 120 |
| Total Counts | 77 | 32 | 22 | 20 | 9 | 24 | 25 | 10 | 219 |

Table 7b. Percentage of Science Benchmark Counts to WA-ELG 5-6 Yrs to NGSS 5-6 Yrs

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| WA-ELG Ages 5-6 yrs | 0.55 | 0.34 | 0.41 | 0.50 | 0.56 | 0.58 | 0.32 | 0.00 | 0.45 |
| NGSS Ages 5-6 yrs | 0.45 | 0.66 | 0.59 | 0.50 | 0.44 | 0.42 | 0.68 | 1.00 | 0.55 |
| Mis-Match | 0.09 | 0.31 | 0.18 | 0.00 | 0.11 | 0.17 | 0.36 | 1.00 | 0.10 |

Figure 8a. Vertical Analysis: WA-ELG, HSCDELF, and NGSS Science Benchmarks Counts by Age Cohorts

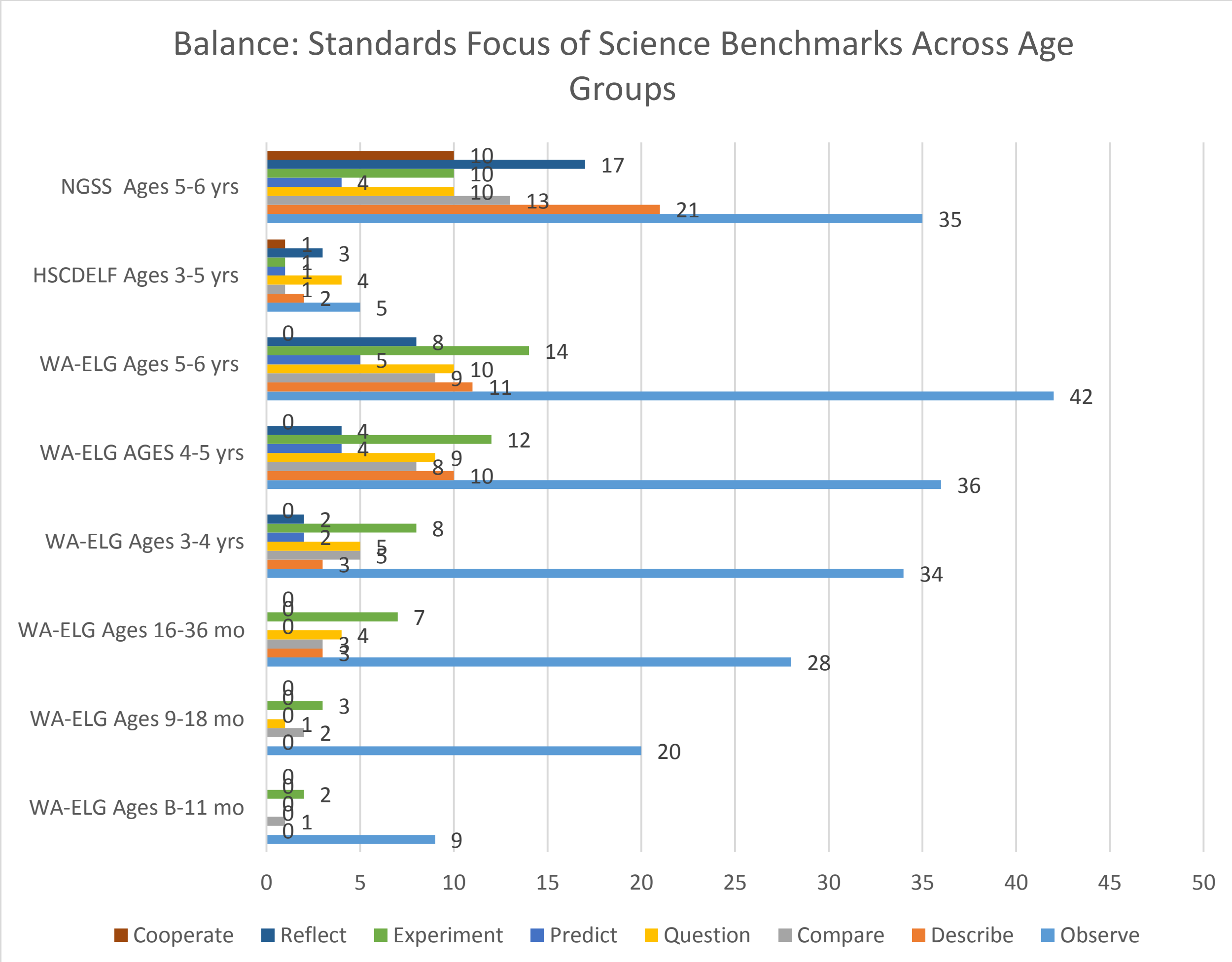



Figure 8b. Vertical Analysis: WA-ELG, HSCDELF, and NGSS Science Benchmarks Overall Counts by Age Cohorts

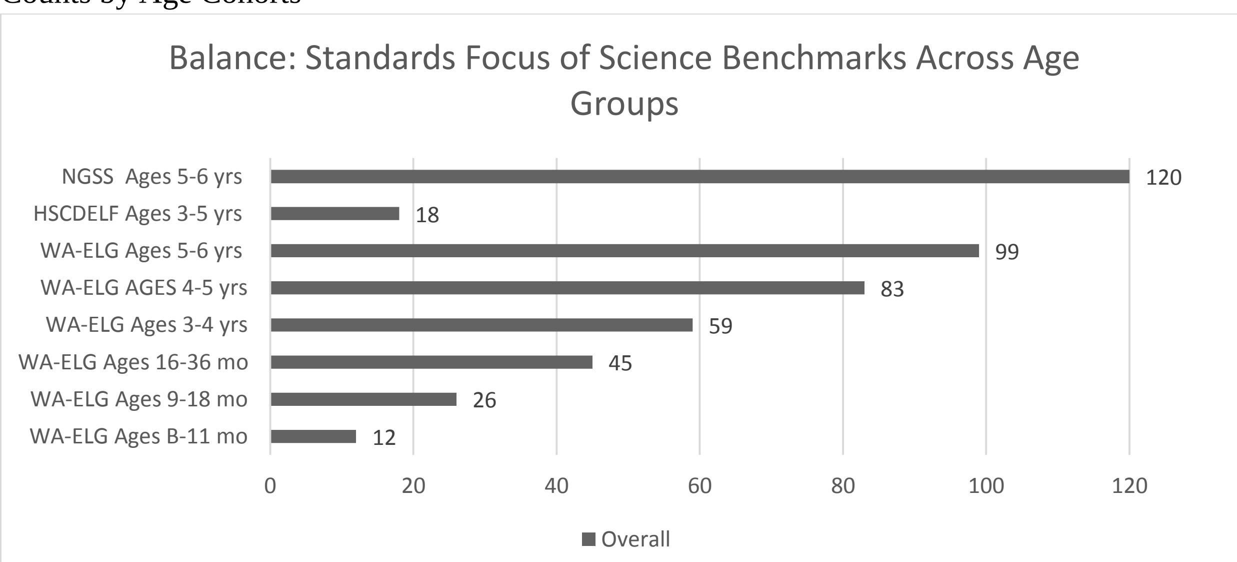


Figure 8c. Vertical Analysis: WA-ELG Counts Across Ages for Each Science Benchmark

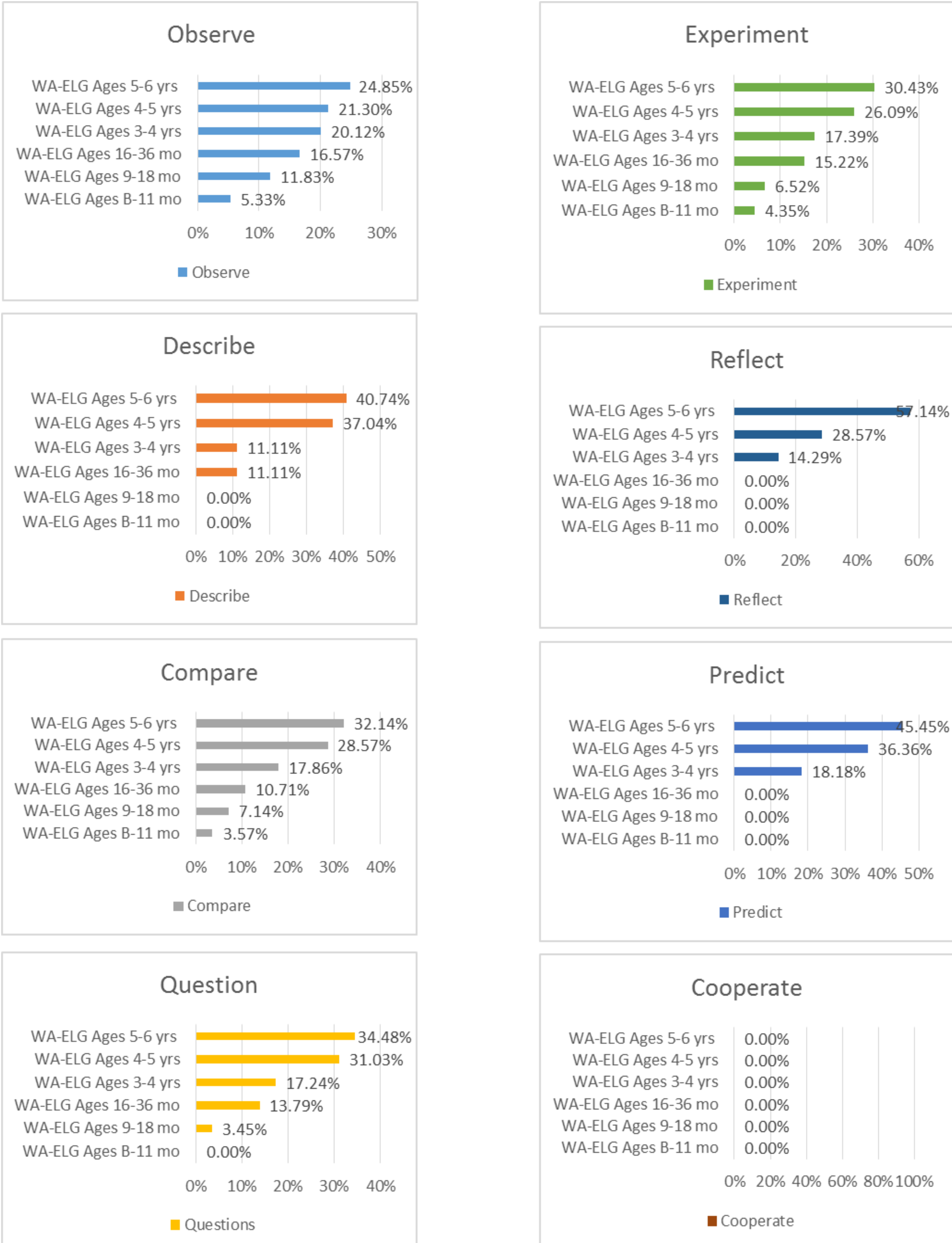


Figure 8d. Vertical Analysis: WA-ELG Counts Across Ages for Science Benchmarks as a Whole

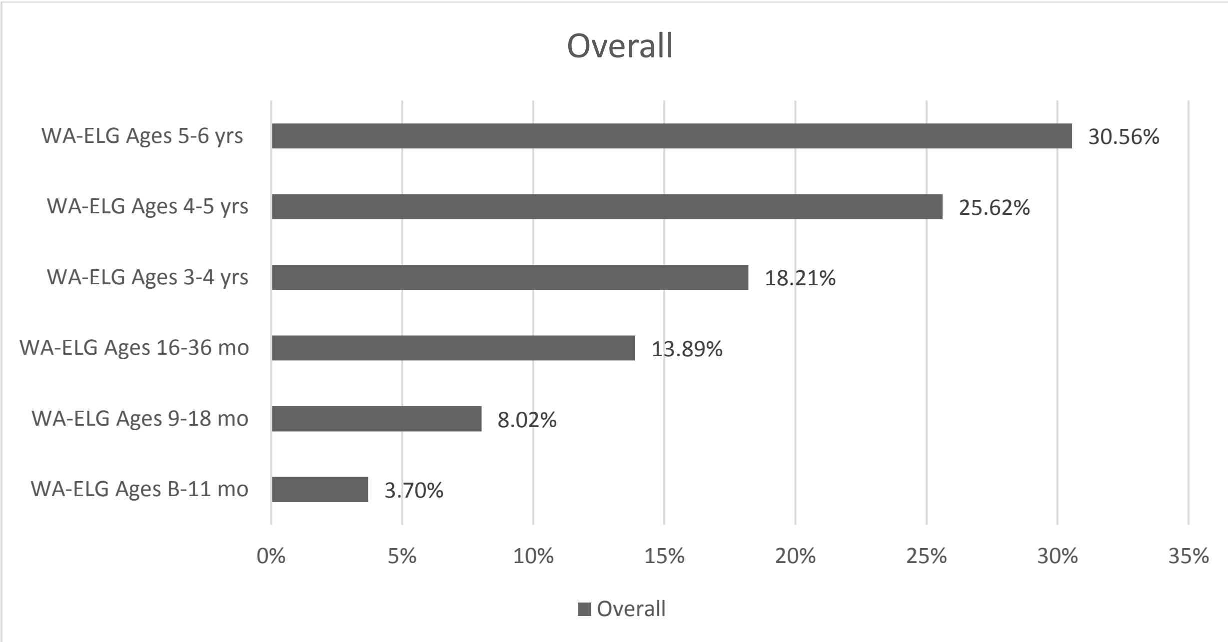
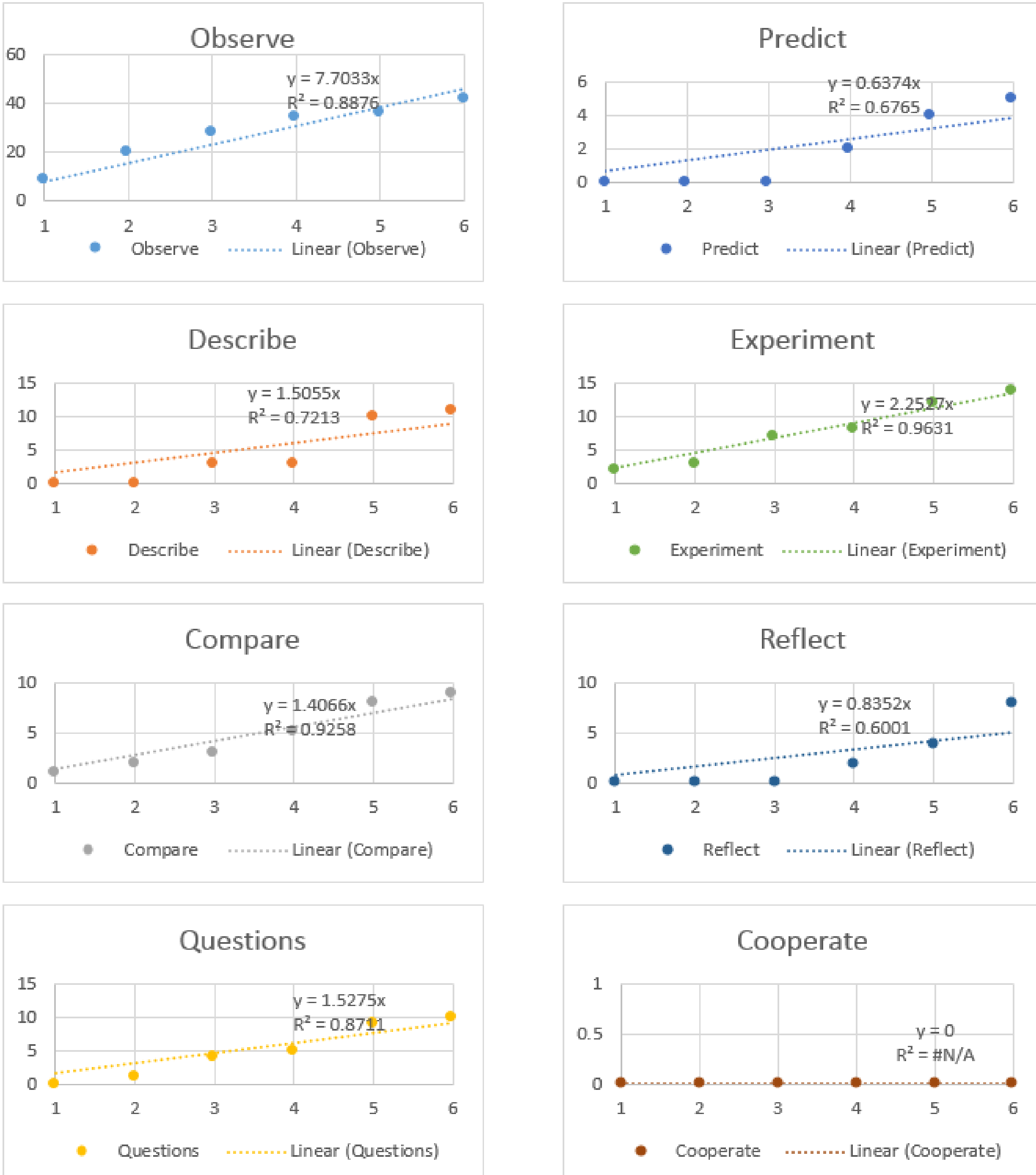


Figure 8e. Linear Correlatins of Science Benchmarks




Key:
1 = WA-ELG Ages B-11 mo
2 = WA-ELG Ages 9-18 mo
3 = WA-ELG Ages 16-36 mo
4 = WA-ELG Ages 3-4 yrs
5 = WA-ELG AGES 4-5 yrs
6 = WA-ELG Ages 5-6 yrs

Table 8a. WA-ELG, HSCDELF, and NGSS Counts of Science Benchmarks Across Age Cohorts

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| WA-ELG Ages B-11 mo | 9 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 12 |
| WA-ELG Ages 9-18 mo | 20 | 0 | 2 | 1 | 0 | 3 | 0 | 0 | 26 |
| WA-ELG Ages 16-36 mo | 28 | 3 | 3 | 4 | 0 | 7 | 0 | 0 | 45 |
| WA-ELG Ages 3-4 yrs | 34 | 3 | 5 | 5 | 2 | 8 | 2 | 0 | 59 |
| WA-ELG AGES 4-5 yrs | 36 | 10 | 8 | 9 | 4 | 12 | 4 | 0 | 83 |
| WA-ELG Ages 5-6 yrs | 42 | 11 | 9 | 10 | 5 | 14 | 8 | 0 | 99 |
| HSCDELF Ages 3-5 yrs | 5 | 2 | 1 | 4 | 1 | 1 | 3 | 1 | 18 |
| NGSS Ages 5-6 yrs | 35 | 21 | 13 | 10 | 4 | 10 | 17 | 10 | 120 |

Table 8b. WA-ELG, HSCDELF, and NGSS Percentage of Science Benchmarks Across Age Cohorts

| | Observe | Describe | Compare | Question | Predict | Experiment | Reflect | Cooperate | Overall |
|---|---|---|---|---|---|---|---|---|---|
| WA-ELG Ages B-11 mo | 0.75 | 0.00 | 0.08 | 0.00 | 0.00 | 0.17 | 0.00 | 0.00 | 1.00 |
| WA-ELG Ages 9-18 mo | 0.77 | 0.00 | 0.08 | 0.04 | 0.00 | 0.12 | 0.00 | 0.00 | 1.00 |
| WA-ELG Ages 16-36 mo | 0.62 | 0.07 | 0.07 | 0.09 | 0.00 | 0.16 | 0.00 | 0.00 | 1.00 |
| WA-ELG Ages 3-4 yrs | 0.58 | 0.05 | 0.08 | 0.08 | 0.03 | 0.14 | 0.03 | 0.00 | 1.00 |
| WA-ELG Ages 4-5 yrs | 0.43 | 0.12 | 0.10 | 0.11 | 0.05 | 0.14 | 0.05 | 0.00 | 1.00 |
| WA-ELG Ages 5-6 yrs | 0.42 | 0.11 | 0.09 | 0.10 | 0.05 | 0.14 | 0.08 | 0.00 | 1.00 |
| HSCDELF Ages 3-5 yrs | 0.28 | 0.11 | 0.06 | 0.22 | 0.06 | 0.06 | 0.17 | 0.06 | 1.00 |
| NGSS Ages 5-6 yrs | 0.29 | 0.18 | 0.11 | 0.08 | 0.03 | 0.08 | 0.14 | 0.08 | 1.00 |

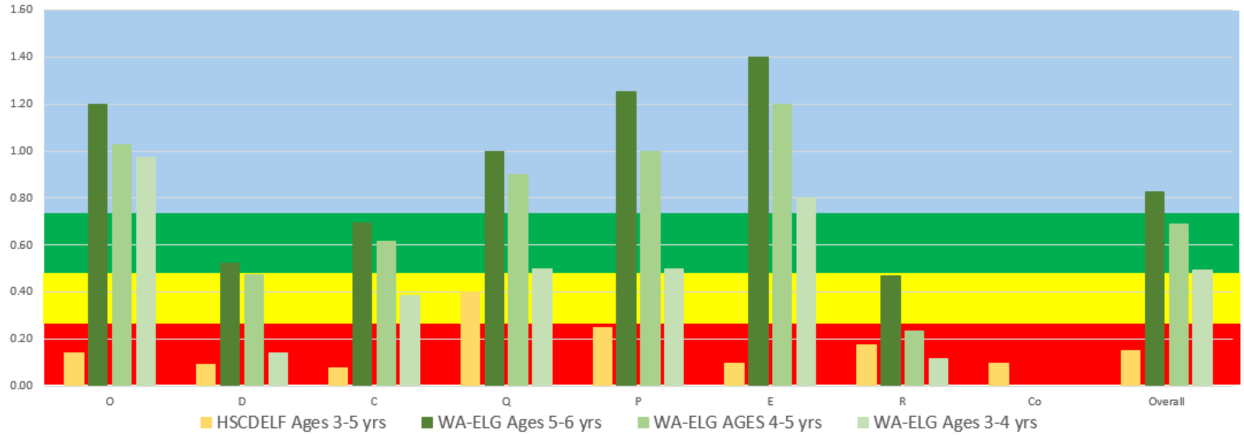
Table 9a. Alignment of Documents

| | O | D | C | Q | P | E | R | Co | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs to WA-ELG Ages 3-4 yrs | | | | | | | | | |
| HSCDELF Ages 3-5 yrs to WA-ELG Ages 4-5 yrs | | | | | | | | | |
| HSCDELF Ages 3-5 yrs to WA-ELG Ages 5-6 yrs | | | | | | | | | |
| HSCDELF Ages 3-5yrs to NGSS Ages 5-6yrs | | | | | | | | | |
| WA-ELG Ages 3-4yrs to NGSS Ages 5-6yrs | | | | | | | | | |
| WA-ELG Ages 4-5yrs to NGSS Ages 5-6yrs | | | | | | | | | |
| WA-ELG Ages 5-6yrs to NGSS Ages 5-6yrs | | | | | | | | | |

Table 9b. Percentage of Counts for Preschool to Kindergarten Expectations, NGSS

| | O | D | C | Q | P | E | R | Co | Overall |
|---|---|---|---|---|---|---|---|---|---|
| HSCDELF Ages 3-5 yrs | 0.14 | 0.10 | 0.08 | 0.40 | 0.25 | 0.10 | 0.18 | 0.10 | 0.15 |
| WA-ELG Ages 5-6 yrs | 1.20 | 0.52 | 0.69 | 1.00 | 1.25 | 1.40 | 0.47 | 0.00 | 0.83 |
| WA-ELG AGES 4-5 yrs | 1.03 | 0.48 | 0.62 | 0.90 | 1.00 | 1.20 | 0.24 | 0.00 | 0.69 |
| WA-ELG Ages 3-4 yrs | 0.97 | 0.14 | 0.38 | 0.50 | 0.50 | 0.80 | 0.12 | 0.00 | 0.49 |

Figure 9b. WA-ELG and HSCDELF meet NGSS Science Kindergarten Expectations




Note: A 1 suggests NGSS Kindergarten Science Expectations are met

**ACKNOWLEDGEMENTS**

The author wishes to express sincere appreciation to the Department of Education for their extended and continued long-term support and especially to Dr. Gail Joseph and Dr. Megan Bang. This thesis would never have been completed without the support and encouragement of my family and friends. This accomplishments is the measure of efforts my family has made, my success is a measure of their success. I would like to thank Jamie Phillips for her continued support and especially Lisa Peterson. Lisa has been a mentor throughout my academic studies. Because of her support and guidance; both academically and personally, I have reached this point.